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What Real Effort Can Do

A POORLY-DRESSED young man stood outside a massive brick building listening to the dull humming sound that emerged from the inside, and watched for the approach of a big blue touring car that he knew would soon pause to let out a big, keen-eyed individual, the general superintendent of one of the largest central stations in the Middle West. The young man, whom we will call Mr. Lane, approached the superintendent and asked for a "job." "Got a trade?" asked the superintendent. "No, sir," replied Lane, "but I'd like a chance. I am interested in electricity." Lane's sincerity of manner appealed to the superintendent and he was told to come inside.

Once inside, Lane was stunned at the magnitude of the place. Powerful electric generators were driven by massive steam engines and turbines; an overhead electric crane was lifting a huge casting off the floor to be put in its place in the assembling of a new unit; engineers and oilers were moving about, and up and down the machinery on the galleries, which were connected by narrow gangways with brass guard rails. There were whistles and bells, and colored lights and what not, and Lane's fondest hope was to help handle these monsters whose constant motion fascinated him.

"Well, young man," said the superintendent, "what do you want to do?" Lane replied: "I am not particular about what I do; what I want is an opportunity to learn and get ahead." "Any education?" asked the superintendent. "I only completed the eighth grade in public school," replied Lane; "I have been working on a farm for my brother." "Humph!" exploded the superintendent; "not very much experience behind you, young man, but I'll put you to work." So Lane was put on the payroll at one dollar per day and was told to report for work the next day.

Lane eagerly waited for his first day among those big, noisy machines. When he appeared at the office, he was immediately put to work—washing windows. Dirty, greasy, grimy windows they were, too, but he did a thorough job; he cleaned every window in that station, wiped the glazed brickwork and cleaned up some of the out-of-the-way corners around the station. He also found time to clean the office furniture and the glasswork about the superintendent's office every day. He kept his eyes and ears open and used his work as a stepping stone to something better. He was soon put in the repair gang, where he handled big sledgehammers and wrenches ten hours a day. He kept plugging along, developing his acquaintance with the operating crews. He got to know Jansen, chief operator on the switchboard, pretty well. Jansen had worked his way up, and he admired Lane and his bulldog tenacity. As time went on Lane got pretty well acquainted with the power-house gang. He worked in the "gang" on repairs for over two years, and became a first-class handy man; he got to know every pipe line in the place, and he knew just how to go about it to start overhauling the machines. By this time he decided to drop the mechanical end of the gang and specialize on electricity, so he asked for a chance on the switchboard. He was enrolled as one of the switchboard crew and put to work cleaning generators, wiping switchboards and oil switches. One day each week he was helper to the regular switchboard operator—here is where he began to develop. When one of the substation operators quit, Lane got his place. After a year in the substation he was put back in the power house as regular board operator. He now started to do things; he recommended little improvements that began to show the superintendent his capacity. After a couple of years on the board as operator he was a well-trained employee.

About this time Jansen, the chief operator, resigned to accept a better position elsewhere. He recommended Lane for his place, and Lane got to be chief operator. Here is where his troubles began, and he was called on to use extraordinary judgment in the discharge of his duties. Some of the other operators had longed to get Jansen's berth, and it did not increase Lane's prestige with his men when they saw him go around them in promotion. There was a reason for his promotion, but they couldn't or didn't see it. He studied hard, worked hard and did not know the latest cabaret singer or how many ingredients there were in a good cocktail; but he did know the value of work. He put every ounce of energy that he possessed into his work, and his love of impartiality and equal justice soon won over his subordinates. He knew the value of concentrated effort and self-reliance. He was chief operator for three years, then became load dispatcher. Here he again showed his master mind by countless new methods of load manipulation, especially during peak loads. From this he went into electric repairs, then to electric construction. He became foreman of electric construction with 100 men under him. He had personal charge of the construction of two new stations, in the electrical end, and since then has been promoted to electrical superintendent of one of the largest electrical syndicates in America. He has a thoroughly organized department of 250 men under him, a corps of assistants who have been trained just as he was, from the bottom round of the ladder. Discipline is one of his mottoes, and his department shows it.

Fearless, loyal and true as steel, severely strict, yet patient when essential—Lane has rounded into a grand old man. Loved by one and all who come in contact with him, a born leader among men, he owes his success to his keen realization of the value of hard and conscientious labor. Not a college man, but a natural-born thinker, abnormally developed through his keen insight and experience as he traveled through the college of life. He is today an acknowledged authority in his profession, has patent rights on some complicated electrical devices and is filling one of the really large electrical positions of today. He never sat down and wished for success—he got busy, and commandeered it.

Central-Station Heating in Detroit

By J. H. WALKER
Superintendent of Central Heating, Detroit Edison Company

Features of the live-steam heating plants and system of the Detroit Edison Co. Reasons why live steam replaced exhaust steam for district heating.

CENTRAL heating as a public utility was originally conceived upon the idea of utilizing exhaust steam from electric generating units. The majority of the systems in operation today, excepting the numerous hot-water installations, use exhaust steam as the distributing medium and by combining the heating and electrical systems secure high thermal efficiency. In some instances, however, it has proved more desirable from a broader economic standpoint to distribute for heating live steam at a relatively high pressure instead of exhaust steam and to operate independently condensing generating plants. Such was the case in Detroit, and it is the purpose of this article to describe some of the features of the live-steam heating plants and systems of the Detroit Edison Co. and to discuss the reasons that led to the abandonment of exhaust-steam heating in favor of the live-steam method. The present heating system in Detroit is a combination of the systems of the Central Heating Co. and the Murphy Power Co., which were taken over by the Edison company in 1910 and 1914, respectively. The district served is about two miles long and one-half mile wide and includes the central business district and what was formerly an exclusive residential district, although now gradually changing to an apartment-house and business section. The total length of mains is about 22 miles, and approximately 1700 customers are served, the buildings heated being shown in Fig. 1. The amount of radiation connected aggregates about 2,600,000 sq.ft. There are four boiler plants having in all 17,470 rated boiler horsepower. In the year 1917 a total of 1,769,000,000 lb. of steam was sold. The steam is used principally for heating buildings, but a considerable amount is used for cocking and water-heating purposes. Only a small quantity is sold for power uses, and this service is being gradually discontinued.

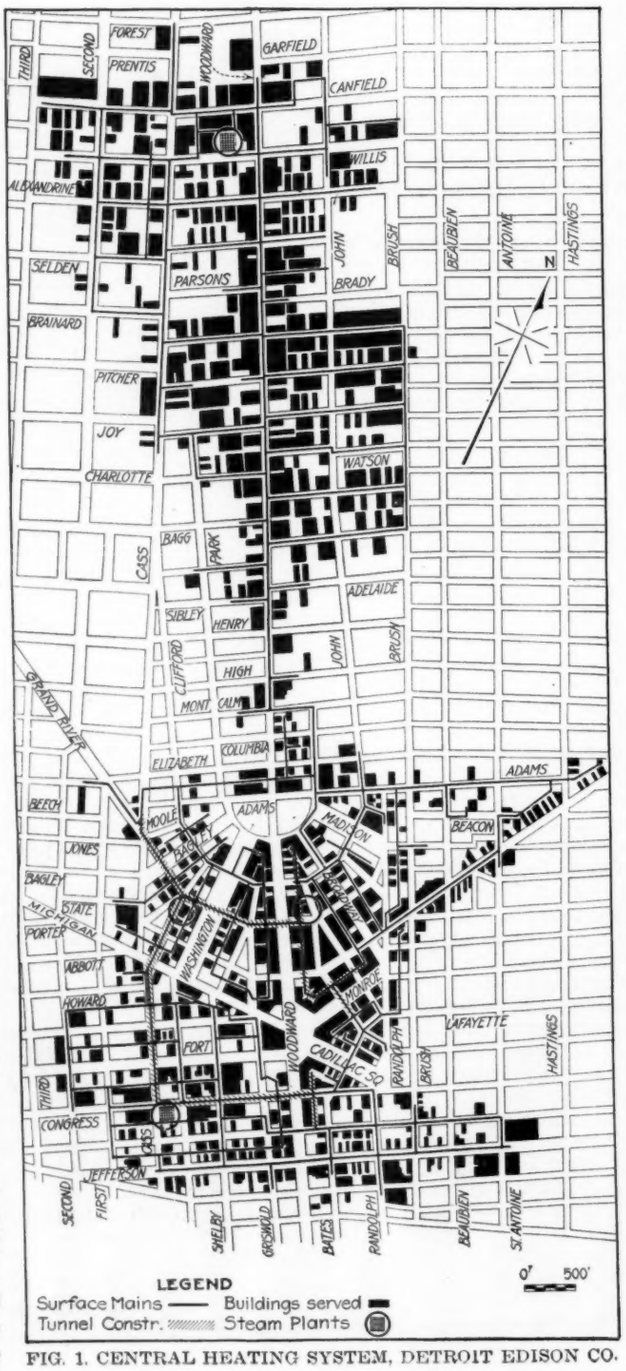


FIG. 1. CENTRAL HEATING SYSTEM, DETROIT EDISON CO.

The pressure carried on one section of the distribution mains constituting about one-third of the total system is approximately 30 lb., while the pressure on the remaining sections, which were originally operated as exhaust-steam systems, is now from 6 to 12 lb. and is necessarily increased from year to year as the load increases. It is expected that eventually the entire system will be operated at a pressure of 30 lb. or higher. The pressure is limited at present by the low allowable pressure of the expansion fittings and in some cases by the lack of reducing valves in the consumers' buildings. All new construction is built for 125 lb. nominal working pressure. In the part of the system on which the pressure is nominally 30 lb., only 10 lb. is guaranteed at the consumer's service valve, this minimum pressure having been found to be entirely adequate for cooking purposes. Thus there is available, under extreme conditions, a pressure gradient throughout the system of 20 lb. This adds considerably to the flexibility of operation and to the capacity of the distribution mains. The boiler pressure carried in the plants is 130 lb., and the steam is delivered direct to the heating system through reducing valves. In comparing the relative advantages of exhaust-steam and live-steam operation, the obvious advantage of the former method is the ther-

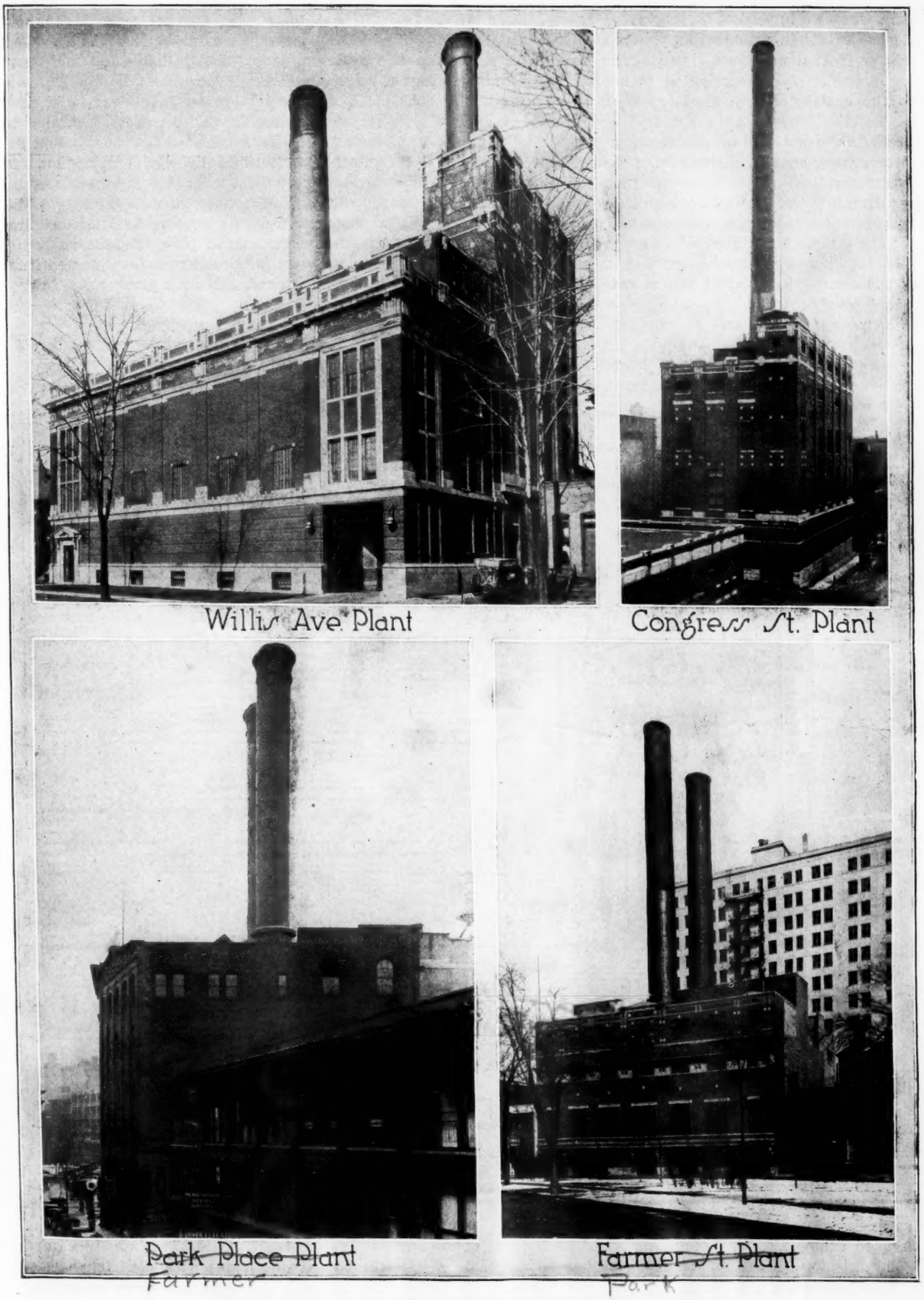


FIG. 2. HEATING PLANTS OF THE DETROIT EDISON COMPANY

mal economy made possible by utilizing the heat in the exhaust steam instead of throwing it away, as is done to a great extent in a condensing plant. Or, looking at the matter from the opposite viewpoint, to carry the steam through electric generating units before delivering it to the heating system makes possible the generating of electrical energy at a low fuel cost. One great disadvantage in distributing exhaust steam, however, is the size of the distribution mains required. If turbines are installed, exhausting into the heating system at a relatively low pressure, the pressure differential throughout the system is, of necessity, very small, and this, together with the higher specific volume of the steam, requires the use of much larger pipes than is the case when steam at a higher pressure is used.

A good example of this condition exists in Detroit. The largest pipes in the portion of the system operated at 30 lb. pressure are 12 and 10 in., while the system formerly operated by the Murphy Power Co. and laid out as an exhaust-steam system, has several hundred feet of 20- and 16-in. pipe and the pipes throughout are considerably larger than in the live-steam system. The two systems cover nearly equal areas and serve about equal amounts of radiation.

The much greater investment in underground lines required in an exhaust-steam system, due to their large size, is perhaps the most potent argument in favor of live-steam operation. A further phase of the matter has developed in Detroit during recent years. Owing to the rapid growth of the heating load the original exhaust steam mains, once thought to be of ample size, have become in many cases entirely inadequate at exhaust-steam pressures. The recent change to live-steam operation with a higher pressure gradient has increased the capacity of the system. Had this not been done, it would have been necessary to replace the large trunk mains with still larger ones.

The installation of high-pressure feeders, as will be described later, has also been of inestimable value in

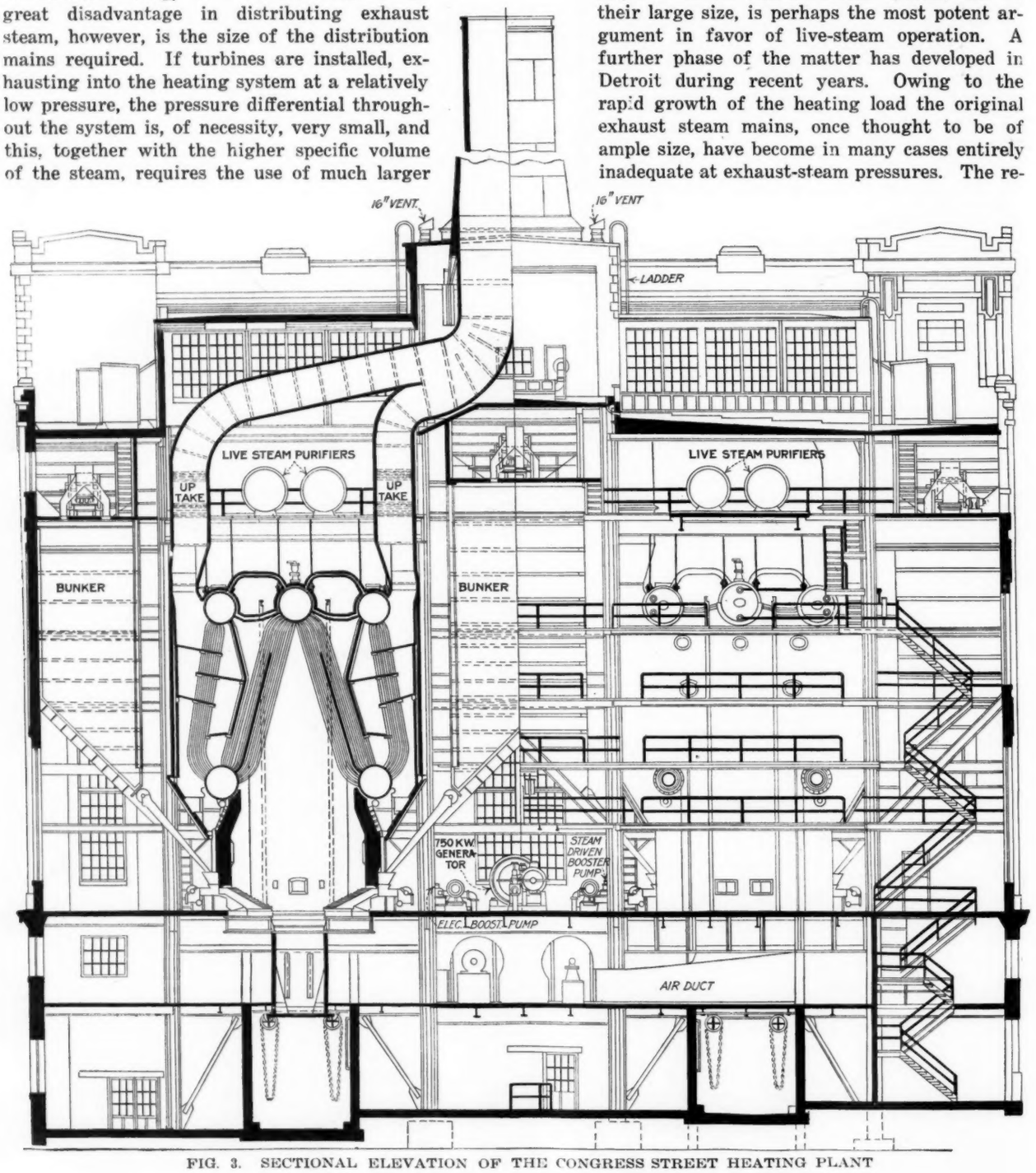


FIG. 3. SECTIONAL ELEVATION OF THE CONGRESS STREET HEATING PLANT

the transmission of steam, and their use would be impossible with complete exhaust-steam operation.

Another equally important point against exhaust-steam operation concerns the investment in plant equipment. The amount of generating capacity that could be installed in the heating plants might aggregate, at the outside, 5000 kw. This capacity would not affect in the slightest degree the actual size of the company's main generating stations, in which the unit most recently added is of 45,000 kw. capacity. The investment represented by the units in the heating plants, together with the building space occupied, would therefore represent additional investment, the annual charges for which, because of the poor annual load factor of the units, would be relatively high per kilowatt-hour generated. Nor would the investment in transmission lines from the main generating stations be in any way reduced. These factors, together with the cost of the necessary attendance per kilowatt-hour—much greater than that in the main generating stations—would also tend to offset the saving due to the lower fuel cost of the current generated.

engineer, and the operation of the plant is controlled almost entirely from the firing floor. Fig. 3 is a cross-section of the plant, and Fig. 4 is a plan view of the present section.

In any steam-power plant an appreciable economy can be gained if the power for driving the auxiliaries is obtained from a prime mover whose exhaust is utilized in heating the feed water. Ordinarily, this is accomplished by the use of steam-driven auxiliaries. The advantages of motor drive, however, as regards speed regulation, low maintenance cost and little attendance are well recognized. In the Congress Street plant the advantages of both kinds of drive will be secured by means of a house-service turbo-generator whose exhaust will be utilized in heating the feed water and which will supply current to the motor-driven auxiliaries. The size of the unit, 750 kw., is such that a good annual load factor will be secured, when the plant is completed, with all the exhaust used in heating the feed water. A considerable amount of current in excess of the requirements of the auxiliaries will be generated and will be fed to the Edison distribution system. The load on the generator will

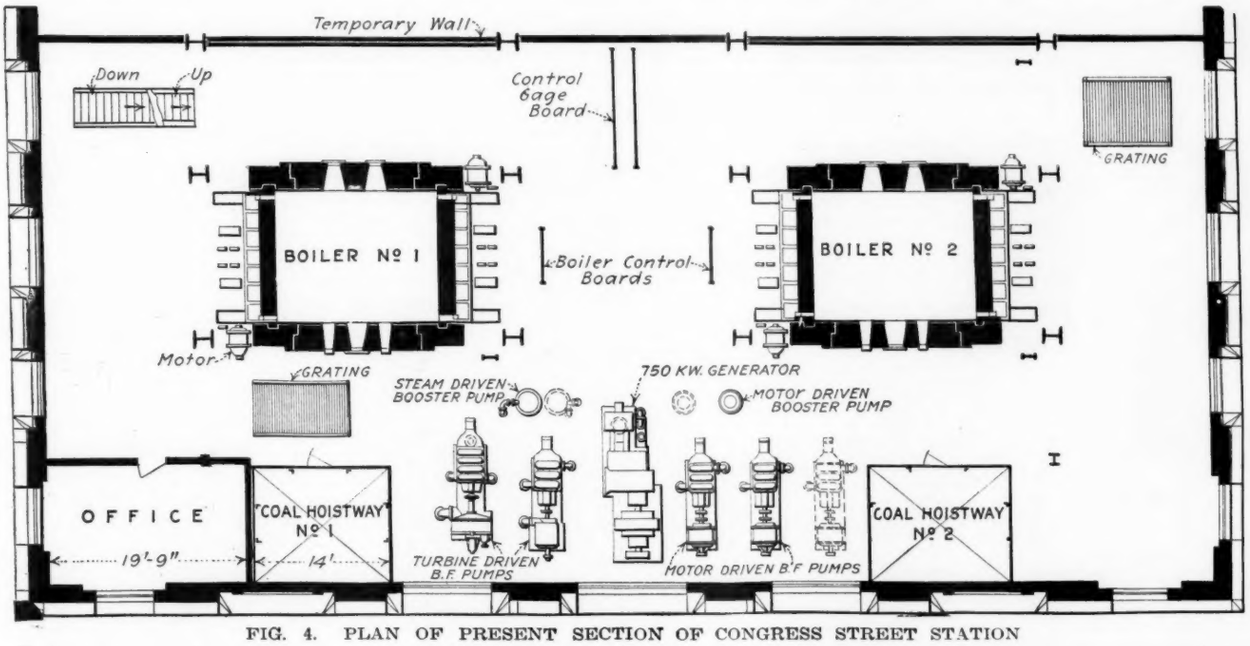


FIG. 4. PLAN OF PRESENT SECTION OF CONGRESS STREET STATION

The four heating plants are shown in Fig. 2. They are equipped, for the most part, with Stirling boilers and underfeed stokers. The newest is the Congress Street plant, the first boiler unit of which was put into service in December, 1917. This plant is designed to contain, eventually, 10,000 rated boiler horsepower, consisting of four 1300-hp. units and two of 2400 hp., capable of being operated at 200 per cent. of rating continuously. The present section contains the first two of the smaller boilers. They are Stirling boilers of the "W" type, quite similar in cross-section to the large Delray and Connors Creek boilers. They are fired from both sides with Taylor stokers.

In the design of the plant an effort was made to select and arrange the equipment so that the size of the operating crew would be reduced to a minimum. To this end the various auxiliary machines are located in so far as possible so as to be within easy reach of the operating

be adjusted as required, so as to furnish the proper amount of exhaust steam. By this means a large quantity of electrical energy will be generated at a low unit cost, without the disadvantages of an exhaust-steam distribution system. The size of the unit is not such that any additional attendance will be required, nor will it occupy any considerable building space.

The turbo-generator and the boiler-feed pumps are located on the firing floor. Both motor-driven and turbine-driven pumps are provided, the former being the ones ordinarily in use and the steam-driven pumps being reserved for emergency service. No injectors are provided.

Like the others, the Congress Street plant is dependent for its water supply upon the city mains. To insure against interruption of the supply in case of failure of the city water pressure, "booster" pumps are provided to augment, when necessary, the pressure

in the mains, sufficiently to raise the water to the boiler-feed pumps. The booster pumps are in the subbasement and are driven through vertical shafts by vertical turbines and motors on the firing floor. As long as the city mains are full of water, even though the pressure be low, the plant will not be without water.

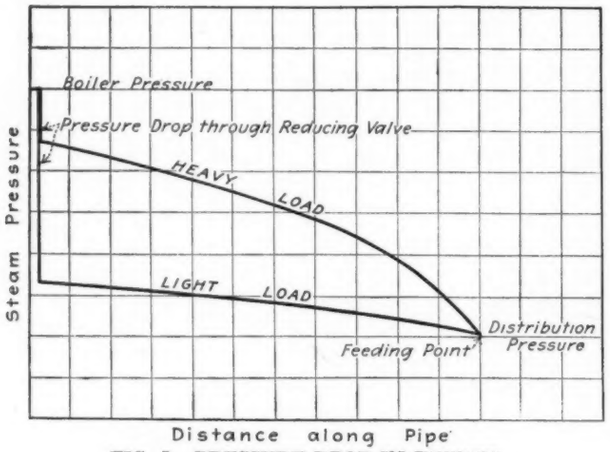
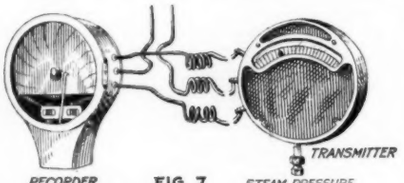


FIG. 5. PRESSURE DROP IN FEEDER

Storage tanks of a capacity sufficient to supply the plant for about one hour when operating at maximum capacity are provided as an additional safeguard.

As very little of the condensation is returned to the plant from consumers' buildings, purification of the large amount of raw water was considered advisable. The Detroit River water is not a bad boiler water, containing but seven grains of total solids per gallon.



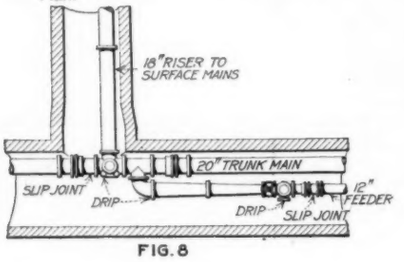


FIG. 6. BOX FOR TRANSMITTER. FIG. 7. LONG-DISTANCE GAGE. FIG. 8. ENLARGEMENT OF FEEDER AT FEEDING POINT

Live-steam purifiers, two to each boiler, are employed to precipitate the scale-forming materials. Careful research in one of the older plants has demonstrated that there is a small amount of additional precipitation of calcium sulphate in the boiler itself due to the concentrating action that takes place. Though relatively small in amount, the scale deposited on the tubes has been sufficient, at high evaporation rates and under certain extreme conditions, to cause overheating and failure of the tubes. In all the plants sodium carbonate is now injected into the boiler-feed water in carefully graduated amounts just sufficient to insure the complete conversion of the scale-forming sulphate to the nonscale-forming carbonate which is removed in the blowoff.

Since the plants are situated, perforce, at some distance from the railroads, it is necessary to haul the coal to them by motor truck. The fuel is received at two coaling stations located on railroad sidings and is there

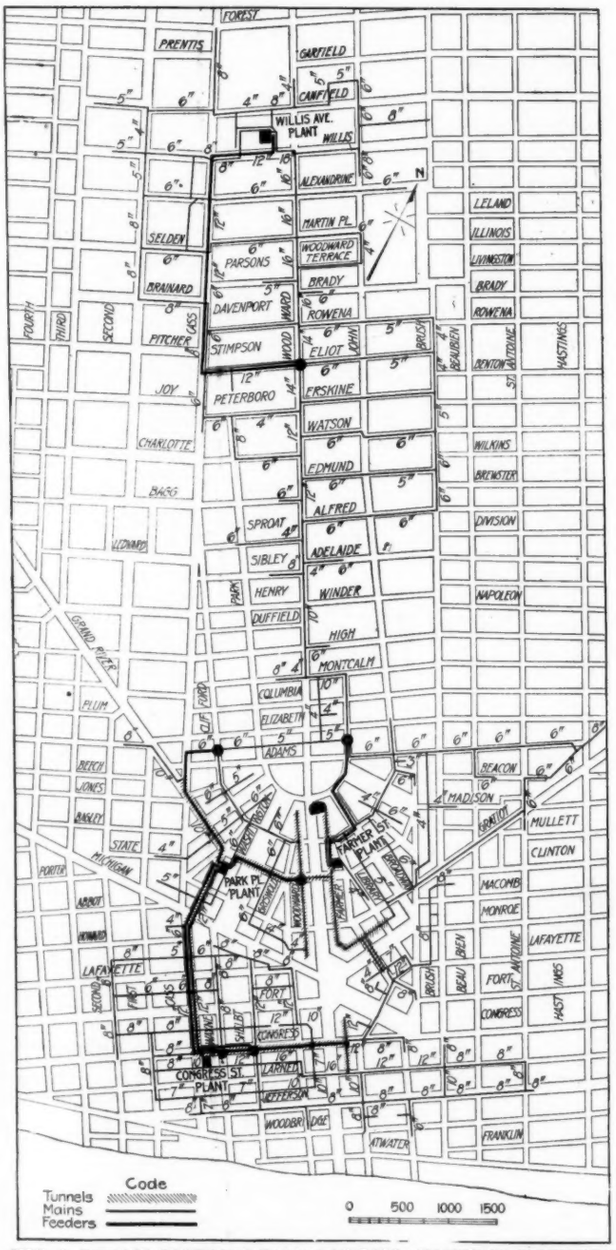


FIG. 9 STEAM DISTRIBUTION SYSTEM, SHOWING FEEDERS

crushed and raised to overhead bunkers, from which it is taken by the trucks. Each truck carries a bucket of six tons capacity and pulls a trailer similarly loaded.

At the Congress Street plant the buckets are hoisted by an overhead traveling crane and are emptied into hoppers from which belt conveyors distribute the coal to the overhead bunkers.

Elimination of all ash-conveying machinery is made possible at Congress Street, by the placing of the boilers at a sufficient height to permit the ash hoppers beneath them to be emptied directly into the trucks that haul the ashes away.

One rather unusual feature of the Detroit system is the method employed for distributing the steam. Although the first mains were installed but fifteen years ago and the majority of them much more recently, the rapid growth of the city and the connecting of large buildings at remote parts of the system have rendered the mains entirely inadequate. To meet this condition

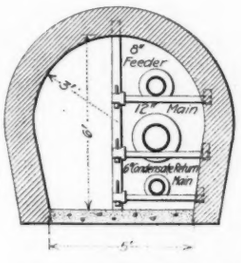


FIG. 10. SIX-FOOT TUNNEL

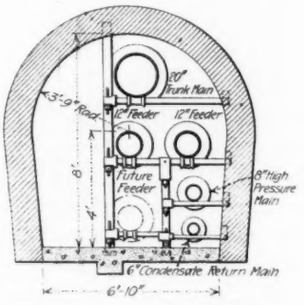


FIG. 11. EIGHT-FOOT TUNNEL

the original pipes are treated as distribution mains, from which the service connections are made, and feeders are installed to transmit the steam from the plants to certain points in the distribution network. No buildings whatever are served from these feeders, their function being simply to transmit steam to the various centers of load. The scheme may be compared to that used in electrical distribution in which feeders, radiating from the generating station, carry current with a large voltage drop to various points in the network of mains.

In selecting the pipe sizes for such feeders, advantage is taken of the large differential between boiler pressure and distribution pressure to reduce the size of the pipes by allowing the pressure drop to take place largely along the pipe itself. In fact, under maximum conditions the entire pressure drop could be allowed to take place in the pipe instead of in the reducing valve. This greatly increases the capacity of the feeder and allows the use of relatively small pipes. The steam is delivered from the boiler header to each feeder through a reducing valve, and the pressure carried is adjusted so as to maintain the required distribution pressure at the remote end of the feeder. The pressure drop in such a feeder is illustrated graphically in Fig. 5. For a light load the pressure drop takes place largely in the reducing valve, while for a heavy load the greater portion of the total drop occurs in the pipe itself.

A record of the pressure existing at the feeding point is furnished to the engineer at the plant by means of an electrically operated long-distance recording gage, and the pressure on the feeder is adjusted as required so as to maintain the proper pressure at the feeding point. A gage of this type is shown in Fig. 7. The street box in which the transmitter is placed is shown in Fig. 6.

The velocity of the steam in feeders of this kind becomes extremely high under conditions of heavy load, reaching, in some actual cases, 75,000 ft. per min. Owing to the large quantities of steam flowing, the radiation loss per pound of steam is practically negligible and the expansion is nearly adiabatic, the steam reaching the feeding point in a superheated condition. It is possibly due to this fact that, in spite of the high velocities attained, there has been no noticeable erosion of the pipe.

To reconvert some of the velocity head of the steam into static head, the velocity of flow is reduced at the end of the feeder by a gradual enlargement of the pipe. A typical connection of this sort is shown in Fig. 8.

There are, in all, six of these high-velocity feeders in service, as shown in Fig. 9. Each is equipped with a long-distance gage and is operated in the manner described.

The heating system includes, in all, about 10,000 ft. of walking tunnels. Tunnels are almost a necessity where several pipes are to be installed, particularly in the congested districts where the blockading of streets for the construction or maintenance of the pipes would be a burden upon the public. The tunnels are all of brick with concrete floors and are built in the horseshoe shape, as in Fig. 10. They are from 30 to 40 ft. below the surface. The greater part of the tunnels is about 6 ft. high by 6 ft. wide, and they contain from one to three steam pipes and a return line. One section is 8 ft. high by 8 ft. wide and contains room for several pipes, as illustrated in Fig. 11. Under the rather favorable soil conditions existing in Detroit, waterproofing of the tunnels, except in a few locations, is unnecessary.

About two-thirds of the total length of surface mains is installed in wood casing and the remainder in a concrete conduit of the form shown in Fig. 12. The latter

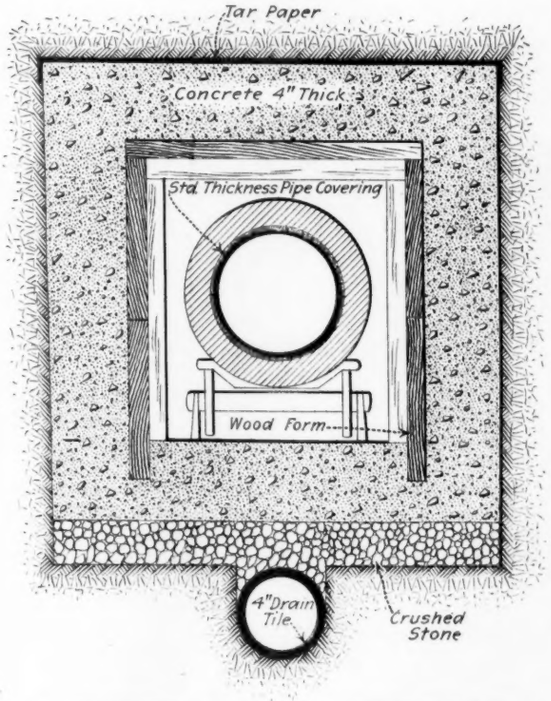


FIG. 12. CONCRETE CONDUIT FOR UNDERGROUND PIPES

type of construction has proved very satisfactory and is being used on all new work. It is made of common materials, is simple to install and is undoubtedly long-lived. Though not entirely waterproof, it is sufficiently so for ordinary conditions.

A test was made in 1913-14 to determine the amount of condensation formed in the distribution mains. In a part of the system operated at that time at a pressure of about 5 lb., the condensation per hour per square foot of external pipe surface was 0.0511 lb. For a section

operated at 25 lb. pressure, the corresponding figure was 0.0593 lb. Both sections were laid partly in wood casing and partly in the concrete construction.

Expansion is taken care of by slip joints in all recent construction. The older lines have joints of the copper-diaphragm type.

Consumers' installations are of no standard design, any well-constructed system being acceptable to the company, subject to certain regulations. New installations are provided with reducing valves. Consumers are urged to install economizing coils to utilize the latent heat in the condensation. These are constructed in the form of an indirect radiator or as a preheater for the domestic water. The steam is sold entirely on a condensation-meter basis.

Luitwieler Single-Plunger Double Acting Pump

Almost any engineer would be skeptical if he were told that a single-cylinder double-acting pump could be designed to operate as high as 100 r.p.m. and deliver a steady stream of water. He knows that a simplex pump delivers its water in a pulsating stream, the water coming from the discharge at its lowest velocity and volume when the piston is reversing its stroke, and he also knows that when a pump is run at a high speed it will pound.

Readers of *Power* will remember that nearly five years ago a description of a Luitwieler double-acting triplex pump was published (p. 53, July 8, 1913). A similar pump is illustrated in Fig. 1. It differs in that it has a single cylinder and plunger. The mechanism, however, is the same; that is, the plunger derives its motion through a cam that is secured to the driven shaft. Rollers carried by the crossheads work against this cam from opposite sides, and the cam is so shaped as to cause the plunger to produce an even flow of water at the discharge throughout the cycle. This pump is manufactured by The Luitwieler Pumping System Company of New York, Rochester, N. Y.

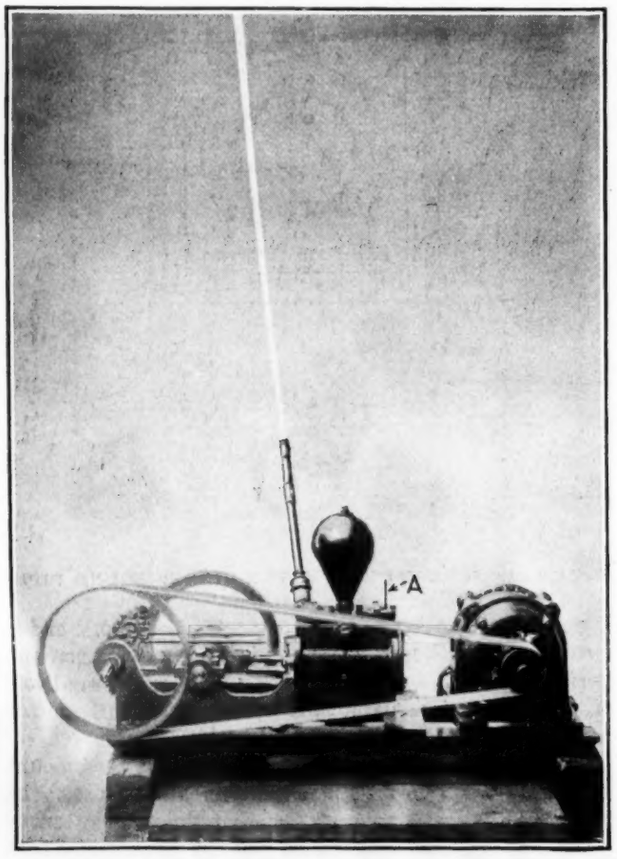


FIG. 1. SINGLE-PLUNGER DOUBLE-ACTING PUMP

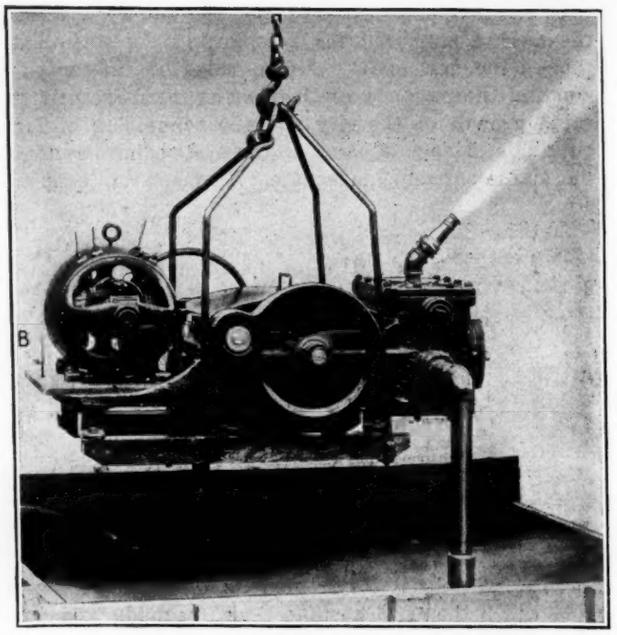


FIG. 2. TRIPLE-PLUNGER PUMP OPERATING ON SUSPENDED PLATFORM

An idea of the steadiness of the discharge stream can be obtained from Fig. 1, where a cam-driven, single-cylinder, double-acting pump is shown in operation. The bore is 5 in., the stroke 5 in. and the revolutions 48 per minute; discharge pressure, 70 lb. The pump and motor are mounted on skids which rest on 6-in. blocking spaced 5 ft. apart. A 4-in. wire nail is shown standing on end at the top plate at *A*, thus indicating the absence of vibration. This pump has been operated at a speed of 100 r.p.m. Water is taken from the reservoir below the pump.

One can hardly conceive of a reciprocating pump being operated without being bolted to a solidly constructed foundation, because of the jar, and yet this has been done with the Luitwieler design, as is shown in Fig. 2, where the pump is suspended from a chain above a tank of water. This pump, which is of the triple-plunger design with 3 x 3-in. cylinders, is shown delivering 82 gal. of water per minute with a pressure that throws a stream 100 ft. through a 1⅛-in. nozzle. The motor speed is 1600 r.p.m., and the pump is running at 150 r.p.m. It will be noticed that there is no air chamber on the water end. The weight of the unit is 1020 lb. The absence of vibration is indicated by the 5-in. wire spike shown standing on end at *B*.

Before you spend money for yourself, think whether your country can afford to have you spend that money. Every dollar saved helps twice, first when you refrain from spending it for nonessentials, and again, when you lend it to the Nation.

The Electrical Study Course—Compound-Wound Generators

It is shown that, owing to the resistance of the armature windings, the voltage at the terminals of a shunt generator will decrease as the current increases, and this variation can be compensated for by the addition of a series winding on the polepieces, making a compound-wound machine.

IN FIG. 3 is a diagram of a shunt generator or motor. In this all that is indicated is the circuits; the armature is indicated as a segmental ring and the field winding as a spiral. However, it will be seen that the field circuit in Fig. 3 is in parallel with the armature, as in Fig. 1. In Fig. 4 the field winding is connected

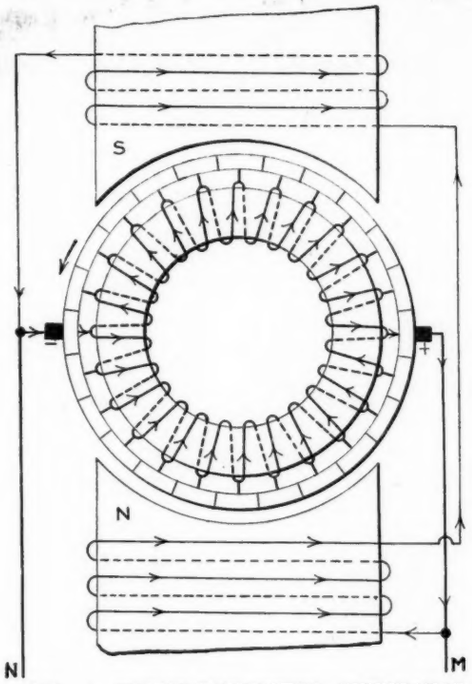


FIG. 1. SHUNT-CONNECTED GENERATOR

in series with the armature as in Fig. 2, making one circuit through the machine in either case. The diagrams, Figs. 3 and 4, provide a convenient means of representing the circuit through electrical machinery, and will be used many times in future lessons.

In Fig. 5 the field coils are shown excited from a source separate from the armature, so that any variation in the voltage at the armature terminals will not affect the strength of the magnetic field. Assume that the armature has 0.23 ohm resistance and generates 115 volts on open circuit, as in Fig. 3 Now, if a resistance of $R' = 5$ ohms is connected across the terminals of the generator, as in Fig. 5, the total resistance of the circuit will be R equals that of the armature and external circuit in series, or $R = r + R' = 0.23 + 5 = 5.23$ ohms, and the current that will flow in the circuit is

$$I = \frac{E}{R} = \frac{115}{5.23} = 22 \text{ amperes.}$$

As has been explained in previous lessons, part of the voltage produced in the armature will be used up in the armature winding to cause the current to flow through this section of the circuit. This voltage e is equal to the resistance of the armature times the current; that is, $e = rI = 0.23 \times 22 = 5.06$ volts. From this we see that when 22 amperes is flowing in the circuit, there is 5.06 volts drop in the armature winding. Hence the available voltage at the armature terminals is $Ea = E - e = 115 - 5.06 = 109.94$ volts, as shown.

Consider what would be the effect of connecting a second resistance of 5 ohms across the generator terminals, as shown in Fig. 6. The joint resistance of r' and r'' is R' equals one-half that of r, or $R' = 5 \div 2 = 2.5$ ohms. Then the total resistance of the circuit is the joint resistance of the external circuit and that of the armature

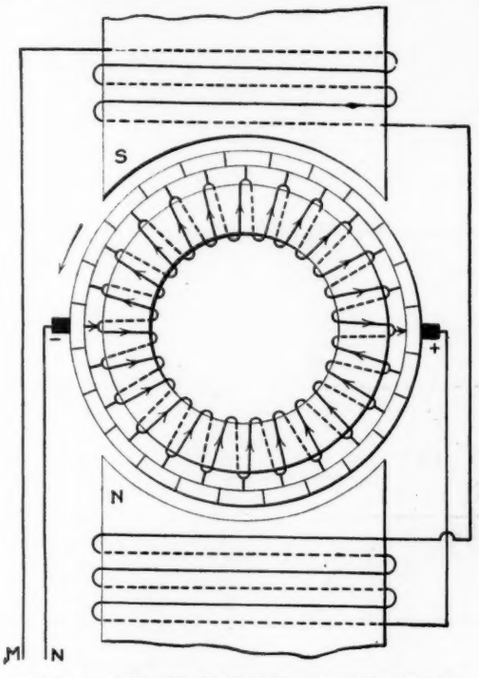


FIG. 2 SERIES-CONNECTED GENERATOR

winding, from which $R = R' + r_a = 2.5 \times 0.23 = 2.73$ ohms, and the current $I = \frac{E}{R} = \frac{115}{2.73} = 42$ amperes approximately. To cause the current to flow through the armature will require a voltage $e = rI = 0.23 \times 42 = 9.66$ volts. This will leave a voltage of $Ea = E - e = 115 - 9.66 = 105.34$ volts available at the armature terminals, as indicated.

From what we have seen in Figs 5 and 6, it is evident that as the load is increased on a shunt generator the voltage at the armature terminals decreases. The voltage generated by the armature would also, to a certain extent, decrease if the field coils are connected to the brushes, as shown in Fig. 3. For the reason that as the voltage decreases across the armature terminals the current will be decreased in the field coils, consequently the number of lines of force will be reduced. In Fig. 5 with a resistance of 5 ohms connected across the armature 22 amperes flowed through the circuit, while in

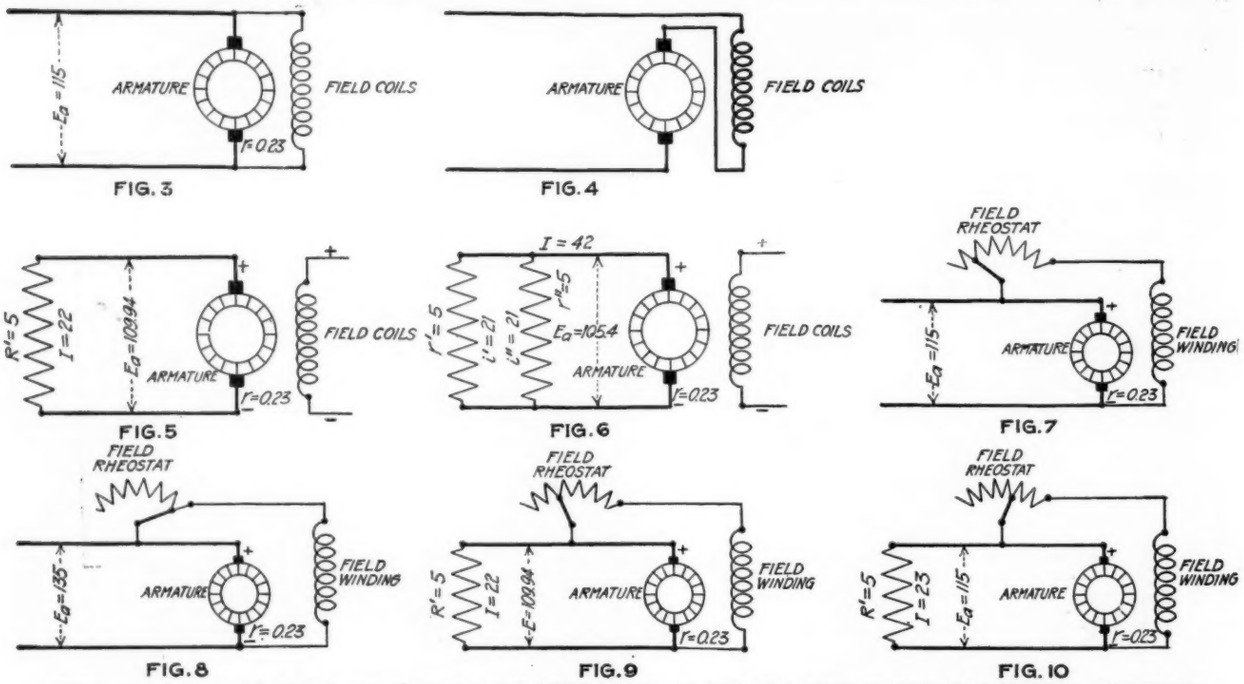
Fig. 6, where two resistances of the same value are connected in parallel, only 21 amperes is sent through each resistance, showing that as the load increases on a shunt generator, unless some means is taken to maintain the voltage constant, the current will decrease in each circuit as more load is connected to the generator.

One way of maintaining the voltage practically constant would be to design the generator for about 20 per cent. over voltage and connect a rheostat in series with the field winding, as in Fig. 7, to reduce the field current to a value where normal voltage would be generated at no load; then, as the voltage falls off because of an increase in load, sections of the rheostat can be cut out of circuit so that the field current will increase to a value that will cause the generator to produce sufficient pressure to maintain the voltage at the armature terminals constant.

For example, with the field rheostat cut out of circuit, as in Fig. 8, assume that the machine will generate 135 volts, and with part of the rheostat cut in series with the field windings, as shown in Fig. 7, the voltage decreases to 115. Then, neglecting the effect of the decrease in voltage at the armature terminals, due to increase of load, on the field winding and connecting a 5-ohm resistance across the armature terminals, as in Fig. 9, the current in the circuit will be approximately 22 amperes and the voltage will drop to 109.94, as in Fig. 5. Now to bring the voltage back to normal, some of the field rheostat can be cut out, as in Fig. 10. This will increase the current in the field coils and in turn increase the field strength, so that the armature conductors will be cutting a greater number of lines of force and producing a great voltage; as is shown in the figure, the voltage has been increased to normal, or 115.

With 115 volts available at the armature terminals, the current in the external circuit is $I = \frac{E}{R} = \frac{115}{5} = 23$ amperes, instead of 22 as in Fig. 9, and the volts drop in the armature is $e = rI = 0.23 \times 23 = 5.29$ volts. Therefore, for the armature to maintain 115 volts at its terminals with a 23-ampere load, it will not only have to generate the 115 volts available at its terminals, but also 5.29 volts to cause the current to flow through the resistance of the windings, or a total of $E = Ea + e = 115 + 5.29 = 120.29$ volts.

After the voltage had been adjusted to 115 at the armature terminals with a load of 23 amperes, if the load was taken off and the field rheostat not changed, the voltage would increase to 120.29 volts, or the total of that generated in the armature. Although, in Fig. 10, only 115 volts is available at the armature terminals, nevertheless, the machine is generating 120.29 volts; 5.29 volts is used up in the armature winding. As soon as the load is taken off, there is no current flowing through the winding to use up the 5.29 volts and it becomes available at the brushes. To bring the volts back to normal again it will be necessary to cut the resistance back into the field circuit, as in Fig. 9.



FIGS. 3 TO 10. DIAGRAMS OF SHUNT-CONNECTED AND SERIES-CONNECTED DIRECT-CURRENT MACHINES.

From what we have seen it is evident that if the load on a shunt generator is varying, the voltage will fluctuate according to the load. Of course, these fluctuations, if they do not occur too rapidly, can be taken care of by the operator adjusting the field rheostat. However, a better way of doing this, if possible, would be to incorporate some automatic means in the construction of the machine to maintain the voltage constant.

In the last lesson we found out that if the load is increased on a series-connected generator the voltage will increase, and decrease as the load decreases. Taking advantage of this fact provides a means of obtaining a close voltage regulation on direct-current generators. This is done by constructing what may be called a combination of a shunt and series machine, or, as it is known, a compound-wound generator. This connection is shown in Fig. 11. From this figure it will be seen that one field winding is connected in series with the armature, as in Fig. 2, and a second field winding connected across the armature, as in Fig. 1. The shunt-field

winding provides the flux to generate about 110 to 115 per cent. normal voltage, the 10 or 15 per cent. excess volts being taken by the field rheostat. The series-field winding sets up the flux necessary to generate the additional voltage to compensate for the volts drop through the armature due to the load current and the resistance of the winding.

In Fig. 11, if the armature is revolved in the direction of the curved arrow, a voltage will be generated in the winding of a polarity as indicated and a current will flow through the shunt-field windings in the direction shown by the arrowheads. This voltage can be regulated to normal by adjusting the field rheostat, or as we will assume, to 115 volts. With no load on the machine no current is flowing through the series-field winding, although some machines are connected so that the shunt-field current flows through the series-field winding.

If a resistance is connected across terminals *M* and *N*, as in Fig. 12, of such value as will allow a current of, say, 25 amperes to flow, as indicated, this current passes

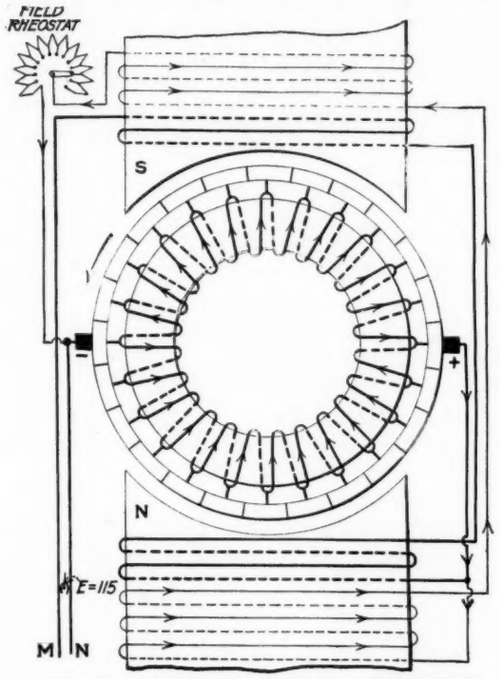


FIG. 11. COMPOUND-WOUND GENERATOR

through the series-field winding and will increase the number of lines of force entering and leaving the armature, consequently the voltage generated in the armature conductors will be increased. On the other hand, the current flowing through the armature will cause a certain voltage drop in the winding. Now if 5 volts is required to cause the current to flow through the armature winding, and the series-field amperes-turns cause the magnetic field to increase in value to where the armature will generate 120 volts, then the 5 additional volts will just compensate for the loss in the armature and the volts at the armature terminals will be maintained constant. If the current supplied to the load is increased to 50 amperes, then the current through the series-field winding will increase to 50 amperes, which in turn will increase the number of lines of force entering and leaving the armature and again cause the volts generated to build up and compensate for the drop in the armature, thus maintaining the e.m.f. constant at the brushes.

The foregoing characteristic of the compound generator, which is nothing more nor less than a shunt generator, having in addition to the shunt winding, a series-field winding on its polepieces, to automatically maintain the voltage approximately constant at its terminals, has caused this type of machine, with certain modifications, to be adopted almost universally for generating direct current. Due to the iron in the polepieces becoming saturated, the lines of force do not increase in proportion to the ampere-turns on the field coils, thus making it impossible to design a compound generator that will maintain absolutely constant voltage from no load to full load. This subject will be discussed in the next lesson.

In problem 1 of the last lesson the copper cable was 1500 ft. long and made up of 37 wires 90 mils in diameter. The cross-section in circular mils of such a cable is equal to the cross-section of one strand times the number of strands. The cross-section of any round conductor in circular mils is equal diameter in mils squared,

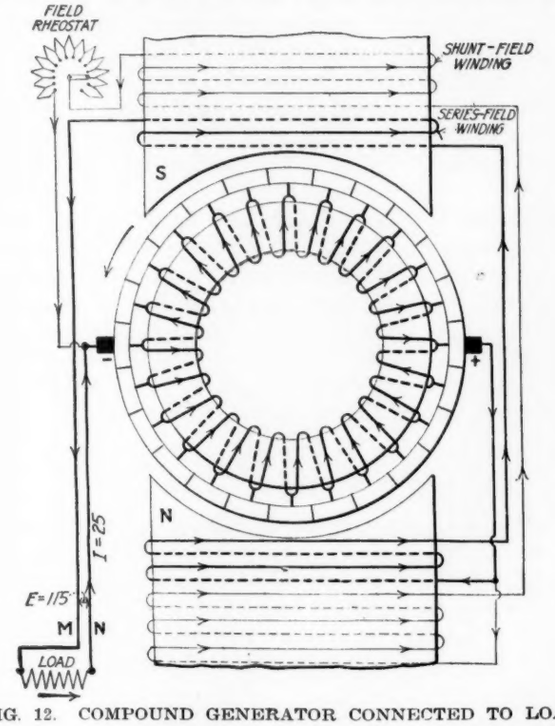


FIG. 12. COMPOUND GENERATOR CONNECTED TO LOAD

or in this case, $90 \times 90 = 8100$ cir. mils, and the cross-section of the cable is $8100 \times 37 = 299{,}700$, approximately 300,000 cir. mils. The conductor's resistance is

$$R = \frac{10.7}{cir.mils} = \frac{10.7 \times 1500}{300{,}000} = 0.0535\ ohm$$

In problem 2 the sizes of the conductors were required to transmit 350 kw. 75 ft. at 250 volts, with 0.5 per cent. drop. The current

$$I = \frac{kw. \times 1000}{E} = \frac{350 \times 1000}{250} = 1400\ amperes$$

Volts drop $E_d = E \times$ per cent. drop $\div 100 = 250 \times 0.5 \div 100 = 1.25$ volts. Then

$$Cir.mils = \frac{21.4DI}{E_d} = \frac{21.4 \times 75 \times 1400}{1.25} = 1{,}800{,}000$$

In transmitting 540 amperes over a circuit 425 ft. long, there is a drop of 16.4 volts in the line. How large is the conductor in cross-section? By how much would these conductors have to be increased in cross-section to transmit the same current with a drop of 10 volts?

Capitalization Value of Steam Leaks

By R. VON FABRICE

Proper consideration of the capitalization values of thermal losses in power plants are too often neglected, although they are ever existent in the best of plants and represent staggering results. Leaky joints in steam lines are given consideration primarily because of the inherent dangers from explosions and destruction of life and equipment. The most numerous steam leaks are from stuffing-boxes, gaskets, leaky valves and free-blowing drips.

THE cost of generating steam represents the greater part of the ultimate cost of power production, and therefore its conservation is of prime importance in reducing the cost of the station output. Economical operation represents a value or bears a direct relation to capitalization, so that an outlay that results in the elimination of losses can be classified as an investment. Steam is the product of expenditures, and the cost is dependent upon the cost of fuel and water, the boiler efficiency and fixed charges made up of interest, taxes, insurance and depreciation. Therefore in a year a pound of steam saved per hour represents a considerable capitalization value to the station; or in other words, it would justify a certain expenditure in order to save the steam.

To ascertain the capitalization value of a pound of steam the cost of the steam must first be determined. Let

K = Cost of steam per 1000 lb. = $\frac{C}{E} + W$;

H = B.t.u. in one ton (2240 lb.) of coal = 2240 $\times$ h;

h = B.t.u. in one pound of coal = 13,500 B.t.u.;

C = Cost of coal per ton (2240 lb.) = $4;

L = Latent heat or B.t.u. required to evaporate one pound of water from and at 212 deg. F. = 970.4 B.t.u.;

F = Boiler efficiency = 70 per cent.;

e = Evaporation per pound of coal = $\frac{hF}{L}$;

$e = \frac{hF}{L} = \frac{13{,}500 \times 0.70}{970.4} = 9.74$ lb. of water evaporated per pound of coal;

E = Evaporation per ton of coal (2240 lb.) = $2240 \times e = 2240 \times 9.74 = 21{,}818$ lb. of steam;

W = Cost of water (10c. per 1000 gal. = approximately 1.2c. per 1000 lb.);

$K = \frac{C}{E} + W = \frac{4}{21{,}818} + 1.2 = 19.53$c. per 1000 lb. of water from and at 212 deg. F.

Having determined the cost of the steam, in order to find the capitalization value the following conditions and assumptions must be kept in mind: (1) Assume a load factor of 100 per cent., that is, that the leak is a continuous drain on the station both day and night; (2) working year to be taken as 8640 hours or 360 days of 24 hours; (3) fixed charges, 17 per cent. of investment per year. The amount of steam lost by a leak is dependent upon the pressure of the steam and the size of the contracted orifice through which the steam escapes.

According to Napier's approximate formula for the outflow of steam through an orifice into the atmosphere

$$W = \frac{Pa}{70}$$

where

W = Weight of steam in pounds per second;

P = Absolute pressure of steam;

a = Contracted orifice (area in sq.in.);

70 = Constant.

Prof. C. H. Peabody conducted a series of tests to check the foregoing formula with pipes ¼ to 1¼ in. long, and the results were close to those obtainable with the Napierian approximate formula.

To illustrate the capitalization value of a steam leak, the following assumptions will be made: (1) Contracted area, or summation of leaks, 0.5 sq.in.; (2) boiler pressure, 250 lb. gage. Then $W = \frac{Pa}{70}$ (weight of steam per second) $= \frac{264.7 \times 0.5}{70} = 1.89$ lb., since $P = 250 + 14.7 = 264.7$; $a = 0.5$ sq.in.; 70 = constant.

Then the loss of steam per hour is $1.89 \times 3600 = 6804$ lb. and for one year of 8640 hours is $8640 \times 6804 = 58{,}786{,}560$ lb.; and the cost per year at 19.53c. per 1000 lb. is $58{,}786.56 \times 19.53 = \$11{,}481$. The capitalization value of the steam lost can be determined as follows:

C = Capitalization value;

F = Fixed charges, assumed to = 17 per cent.;

K_2 = Total cost of steam lost.

Hence

$$C = \frac{K_2}{F} = \frac{11{,}481}{0.17} = \$67{,}535$$

The accompanying chart has been worked out, by means of which similar problems may be readily solved, and to illustrate its use the foregoing problem has been plotted on it. Beginning with the upper left-hand section, selecting the B.t.u. or heating value of the coal, say 13,500 B.t.u., follow vertically down to the diagonal line representing the over-all boiler efficiency (70 per cent.), thence horizontally to the right, crossing the vertical scale, showing the pounds of water evaporated per pound of coal, which in the problem given is 9.74 lb.; then continue to the upper right-hand section to the intersection of the curve giving the cost per ton (2240 lb.) of coal ($4) and thence downward parallel with the vertical lines at the top of which is given the cost, in cents, of evaporating 1000 lb. of water from and at 212 deg. F. (in this case 18.33c.). Then continue downward, intersecting the diagonal line in the middle right-hand section, representing the cost of water (in this case 10c. per 1000 gal.), thence to the left to the vertical scale, where the cost of one pound of steam per hour per year (of 8640 hours) is given as $1.69; then

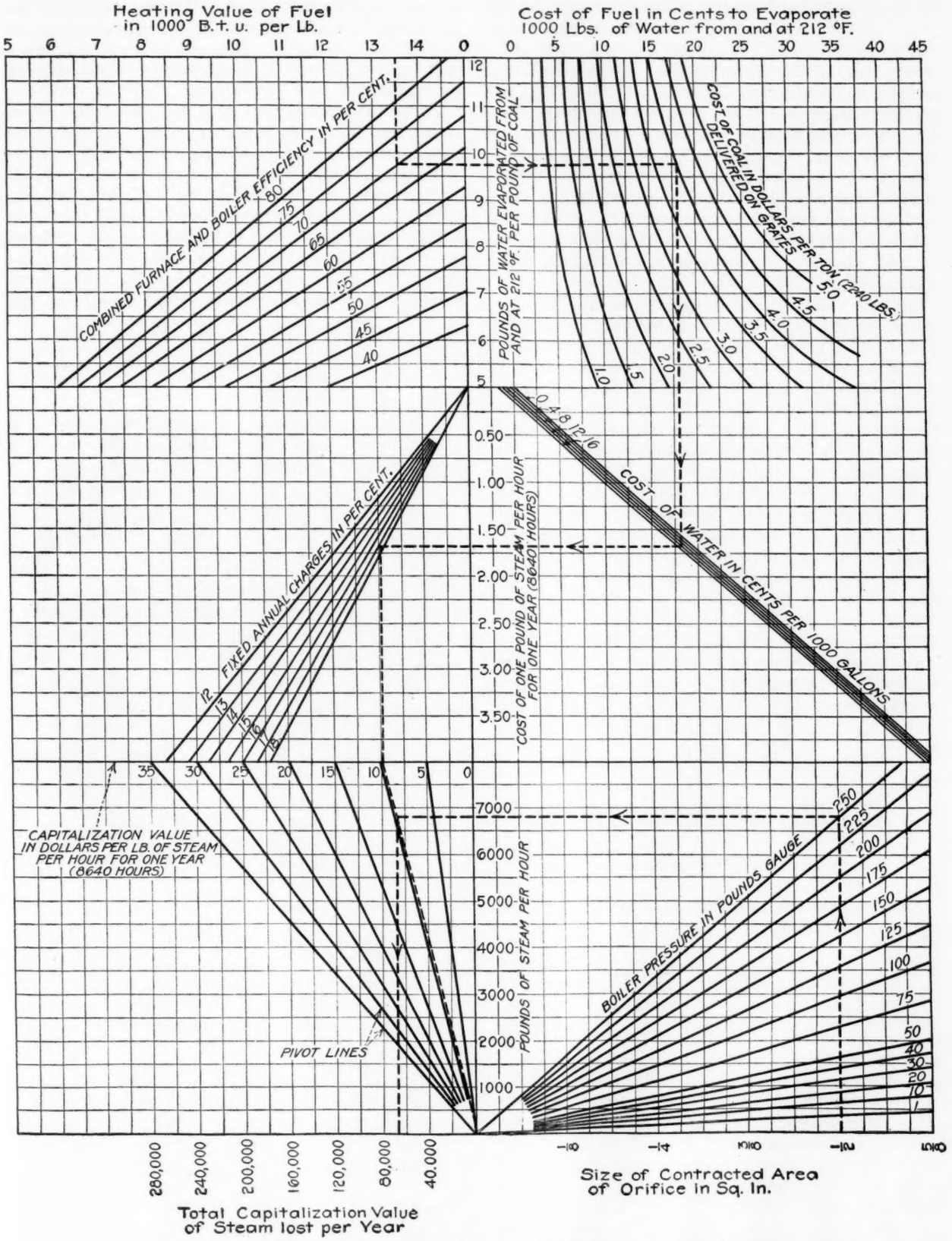

Heating Value of Fuel in 1000 B.t.u. per Lb.
Cost of Fuel in Cents to Evaporate 1000 Lbs. of Water from and at 212 °F.
COMBINED FURNACE AND BOILER EFFICIENCY IN PER CENT.
POUNDS OF WATER EVAPORATED FROM AND AT 212 °F. PER POUND OF COAL
COST OF COAL IN DOLLARS PER TON (2240 LBS.) DELIVERED ON GRATES
FIXED ANNUAL CHARGES IN PER CENT.
COST OF ONE POUND OF STEAM PER HOUR FOR ONE YEAR (8640 HOURS)
COST OF WATER IN CENTS PER 1000 GALLONS
CAPITALIZATION VALUE IN DOLLARS PER LB. OF STEAM PER HOUR FOR ONE YEAR (8640 HOURS)
PIVOT LINES
POUNDS OF STEAM PER HOUR
BOILER PRESSURE IN POUNDS GAUGE
Total Capitalization Value of Steam lost per Year
Size of Contracted Area of Orifice in Sq. In.

CHART SHOWS ANNUAL LOSS FROM STEAM LEAKS AND ITS CAPITALIZATION VALUE

continue to the left to the diagonal lines representing the fixed charges (taken at 17 per cent.), thence downward to the horizontal base line, giving the capitalization value per pound of steam per hour per year of 8640 hours (which is $9.94). From this point of intersection draw a diagonal line through the lower left-hand section of the chart to the point of intersection of the vertical scale, or center line. Then start on the base of

the lower right-hand section of the chart at the point giving the contracted area of orifice (or the sum of all), which in this case is ½ sq.in., and follow upward to the intersection of the diagonal line, giving the steam pressure in pounds gage (in this case 250 lb.). From this intersection turn to the left, intersecting the vertical scale between the lower sections, giving the pounds of steam per hour (6804 lb. in this case), then continue across to the diagonal pivot line previously referred to (drawn from the capitalization value per pound of steam per hour for a year to the apex) and drop down to the horizontal base of the lower left-hand section, giving the total capitalization in thousands of dollars, which in the given case is $67,535.

The heat values for the foregoing problem have been reduced to feed water at 212 deg. and steam at 212 deg. F., or "cost of steam from and at 212 deg.," as is done in boiler-evaporation tests, because proper corrections must be made for the additional B.t.u. absorbed for the given conditions. The factor for reducing the weight of water actually converted into steam at any given pressure and feed-water temperature to the equivalent evaporation "from and at 212 deg. F." is called the "factor of evaporation," which is the ratio of the total heat necessary to produce one pound of steam "from and at 212 deg. F." to the heat used in heating the feed water from a lower temperature to steam at the temperature corresponding to the higher pressure, or is the difference between the total heat of evaporation under different conditions. Thus in the given case, for feed water at 160 deg. F. and steam at 250 lb. gage (264.7 lb. absolute) the factor of evaporation is found to be 1.1073, as per tables, or it can be determined by the following formula

$$F = \frac{H - h}{970.4}$$

when

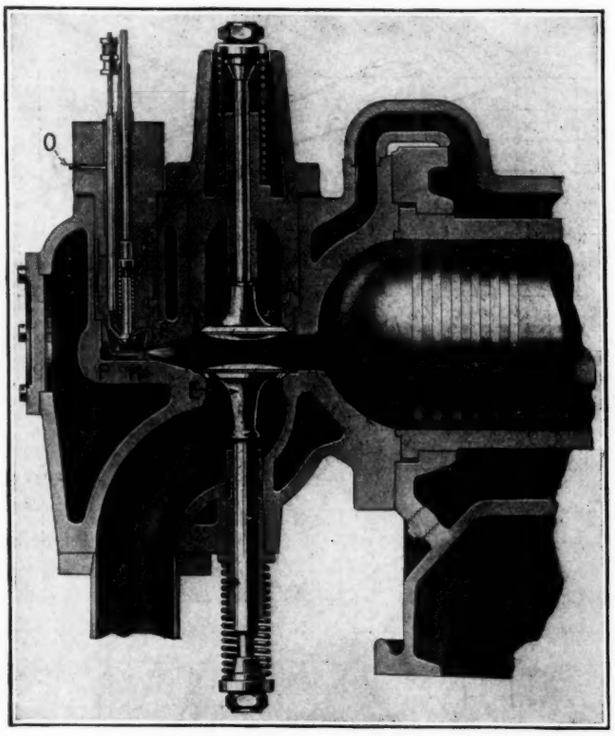
F = Factor of evaporation;
H = Total heat of steam above 32 deg. F. (from steam tables);
h = Sensible heat of feed water above 32 deg. F.;
970.4 = Latent heat of evaporation "from and at 212 deg. F."

Lyons Atlas Heavy-Oil Engine

A new type of heavy-oil engine has recently been placed on the market by the Lyons Atlas Co., Indianapolis, Ind. This engine, in contradistinction from many other types of heavy-oil engines, uses no air compressors or fuel pumps. The figure gives a cross-sectional view of the cylinder head, showing the position of the air, fuel and exhaust valves and the location of the piston at the end of the compression or the beginning of the power stroke.

On the first outward stroke the air valve A opens, and a charge of pure air is drawn into the cylinder during this stroke. Simultaneously with this operation, the fuel valve F opens and allows a small quantity of fuel oil to flow into the primary cup P, located in the combustion chamber attached to the cylinder head. The oil flows by gravity into the opening O, the amount being controlled by the governor according to the load and speed. On the return stroke all valves are closed and the charge of air in the cylinder is compressed into the combustion chamber to a pressure of about 450 lb. per sq.in. This increases its temperature to about 900 deg. Fahrenheit.

When the piston has about completed its return stroke, the temperature of the air in the combustion chamber becomes high enough to vaporize the lighter hydrocarbons in the fuel, in the primary cup P, exactly the same way as in an oil-refinery still. This vapor is ignited by the high temperature and expands, creating a high pressure on the oil in the primary cup at almost the same instant that the piston reaches the end of the combustion stroke and is about to start on the power stroke. The pressure created in the primary cup, due



SECTION THROUGH ENGINE-CYLINDER HEAD

to the burning of the lighter hydrocarbons, is sufficient to force the remaining liquid in the primary cup out through small holes H in the cup, causing the fuel to be broken up into fine spray as it enters the combustion chamber. Here the atomized fuel encounters the high temperatures due to compression, ignites and burns during the entire power stroke. The oxygen in the air admitted to the cylinder on the previous suction stroke is sufficient to result in very efficient combustion during the entire power stroke.

The combustion is gradual, no explosion taking place. Indicator diagrams show that the pressure in the combustion chamber rises very little above that due to compression of the air on the first return stroke. The force on the piston during the power stroke is similar to that on the piston of a steam engine.

During the second return stroke, or last stroke of the cycle, the exhaust valve E opens and the piston drives the burnt gases out to the atmosphere, thus completing the cycle when the piston reaches the end of the stroke. The amount of vapor burned in the primary cup is small,

and its effect upon the pressure in the combustion chamber, as shown by an indicator diagram, is scarcely perceptible.

These engines are built in two sizes, 20 and 30 hp., and will burn crude and fuel oil, kerosene and intermediate distillates of such characteristics as to be thoroughly combustible and sufficiently liquid to flow freely at ordinary temperatures to the primary cup by gravity under a head of two feet. The fuel consumption, based upon a minimum net or effective heat content of 18,500 B.t.u. per lb., is guaranteed not to exceed 0.6 lb. at full load, 0.66 lb. at 75 per cent. full load and 0.78 lb. at 50 per cent. full load.

The engines are started by compressed air from a storage tank, on the oil they use for fuel, without any preheating or other preparation, and can start from a cold standstill and attain full speed in less than two minutes, regardless of climatic conditions.

A Breakdown Aboard Ship

BY JOHN MELVILLE

The following account of a breakdown which happened to the engines of a steamer on which I was chief engineer may be of interest to *Power* readers in view of the active interest being taken in marine engineering at the present time.

We left Rotterdam (pre-war days) with a cargo of coal and proceeded down the river, everything running smoothly and well. Shortly after we had dropped the pilot and were heading at full speed for the Straits of Dover, a tremendous bumping caused me to rush to the engine room, where the second engineer already had the engines stopped. It had all happened so suddenly that there was no chance to locate the cause of the trouble, and nothing unusual showed to give us a clue. Being satisfied that something was wrong inside one of the cylinders, we proceeded to open them up. Their dimensions were: High-pressure, 25 in.; intermediate, 41 in.; low pressure 67 in.; stroke, 45 in. As far as the second engineer could judge, the noise came from the intermediate cylinder, but on opening it we found it in good condition. On opening up the high-pressure cylinder, however, we found a sorry mess; the piston was smashed into "a thousand and one" pieces, caused by one of the junk-ring bolts breaking at the end of the thread. There being insufficient clearance between the piston and cylinder cover, something had to go, and apparently the piston was the weakest part. Fortunately, after a few strokes the broken bolt got opposite one of the core plugs on top of the piston, and on the next stroke the core plug was forced in and the broken bolt jammed in the hole, thus preventing any further damage.

To operate the engines as a triple-expansion set was out of the question, so we made ready to run on two cylinders. The pieces of the broken piston were removed, but the piston rod with the crosshead and guide shoes was left in place, the piston rod thus serving to keep the gland steam-tight. With the piston valve and valve gear removed and the covers replaced, we were ready to proceed. The boiler pressure was reduced from 175 to 100 lb. No trouble was experienced in starting the engines, and we headed for Deal, where we could report the accident to headquarters. Orders were received there to proceed to Plymouth, where a new piston would be sent us.

The trip down the English Channel was uneventful though somewhat slow, but the engines gave no trouble, even though they were somewhat out of balance due to the cranks being at 120 deg. The coal consumption on the "pounds per indicated horsepower" basis was largely increased, but that was to be expected with a reduced initial pressure and the consequent reduction in the number of expansions by the loss of one cylinder. The limits of the valve gear prevented us cutting off early enough in the new high-pressure cylinder to give the previous ratio of expansion.

On arriving at Plymouth, the first job was to get the piston rod out to find out whether it had become bent in the smash. The limited means we had on board ship for testing proved that the rod was damaged, so it was sent ashore to a repair shop. When placed in the centers of a lathe, a double bend was found at the tapered part which fitted into the piston. The straightening of the rod, which was 6¾ in. diameter, proved to be a difficult job, but by means of a charcoal fire, wooden blocks and mallets the blacksmith managed to get it nearly true and comparatively free from marks and scaling. When tested in the lathe again, only a slight cut was required to bring the tapered part true. This allowed the piston to go ¼ in. farther on the rod, but there was sufficient clearance in the cylinder to allow for this.

Having got the new piston fitted to the rod, no time was lost in having it placed on board, where everything was ready to handle the job with dispatch. It was 2 p.m. when the piston and rod were on deck, but we were ready to sail by 10 p.m. On the voyage out and home again no defects developed, and so far as I know the same engines are doing duty still.

Some of the things we did, or rather the things we omitted to do, in connection with this job are open to criticism, such as neglecting to close up the steam ports in the high-pressure cylinder and not changing the cranks to 90 deg.; but the distance we had to travel to the nearest port was not great, and we were anxious to get under way again in the shortest possible time.

Another Coal and Liquid Fuel Mixture

A substitute for coal has been patented by the Industrial Fuel Corporation, of Long Island City, N. Y. The underlying scientific theory is, as outlined in the letters patent, the first claim being as follows:

> A fuel composition consisting of loose coal dust or screenings and a high boiling liquid fuel having low viscosity at ordinary temperatures, the amount of such liquid being merely such as will wet the faces of the coal particles without filling the voids therebetween to a substantial extent, and such liquid fuel being of sufficiently high boiling point to insure persistence of a substantial amount of liquid fuel in the mixture until such mixture is at or near the ignition point of the coal.

The composition is fired loose, the same as ordinary coal.

In other words, a liquid having the easy flowing qualities of water is mixed in the proportion of 1 to 20 with anthracite screenings. Because of the high boiling point of the liquid, it remains with the screenings, keeping the mass moist, up to the point at which the carbon in the coal ignites, and once the loose material actually

begins to burn, the problem of stability in the fire is solved.

According to the New York *Sun*, this idea of burning low-grade fuel was anticipated by the New York Architectural Terra-Cotta Co., of Long Island City.

Many months ago this company was unable to buy any soft coal in the New York market, but had no difficulty in securing culm. Prior to that time, an officer of the company had found that by mixing about 5 per cent. of a special liquid fuel with 95 per cent. of this coal dust a fuel might be obtained of such consistency that it would neither fall through the grate bars nor go up the chimney under forced draft.

The experiment was tried out in practical use and proved to be a complete success. For many months this company has used no other fuel under its boilers and has obtained a maximum of efficiency with a saving of nearly 50 per cent. in expense.

The new fuel was examined by Dr. C. E. Davis in the laboratories of the Columbia University Department of Chemical Engineering and upon calorimeter test showed a calorific value of 13,950 B.t.u. to the pound, or a heating value about equal to that of anthracite.

The special liquid referred to is a byproduct obtained in the manufacture of carburetted water gas and has always been considered of minor importance. Millions of gallons are produced annually in the United States.

It would seem from the foregoing that this fuel is along the line of similar fuels in which a binder is mixed with fine coal before it is pressed into briquets. In this instance, however, the coal and binding mixture is fired in a loose state.

Oil Lantern Jammed on Piston Rod

BY E. W. MILLER

The machine was of 50-ton capacity, having two double-acting ammonia compressors with the steam cylinders between the two, the entire unit being vertical. A knock developed and gradually grew worse, sounding like that produced by striking a large piece of metal with a light hammer.

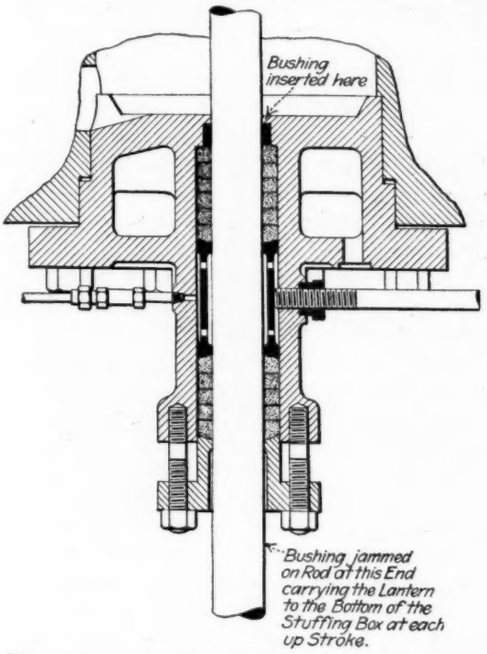
The engineer concluded that it was in one of the compressor valves. He had expected by the sound of the machine to find that one of the springs had broken or become too weak, but was surprised to find that the valve and spring were in good order. He oiled the valve liberally and took particular care in replacing it to make sure that there should be nothing to interfere with its operation.

When he started the machine, the knock was as bad as before. It seemed impossible to find the source—so much so that he thought at times that it was somewhere in the steam cylinder or its valve gear. Finally, he shut the machine down and went over every part of the compressor, removing the valves, testing the clearance and keying up on all the bearings and taking up all lost motion.

The knock was still there when he started the compressor again, and the machine was once more shut down and pumped out and the piston removed from both the one ammonia compressor and the engine. The engine piston was removed first and nothing wrong was found. When he came to remove the compressor piston, he found that it came out with difficulty, and to facilitate its removal it was decided to remove the packing.

When the packing had been removed up to the oil lantern, it was found that the lantern refused to budge. The piston was lowered in the cylinder, and at the same time one of the men maintained a steady pull on the lantern. It came down without any trouble. When the piston was lowered sufficiently to bring the lantern out of the stuffing-box, it was found that the lantern was jammed fast on the piston rod at this point. The lantern had been babbitted and turned to a snug fit on the rod, and at some time the rod had become hot enough to partly melt the babbitt. At the same time some shreds of packing had worked through some of the holes in the center of the lantern and squeezed into the molten babbitt, and when the babbitt set again, probably due to a sudden cooling of the machine from a slug of liquid in the suction gas, it had formed a tight fit on the rod. The packing had wedged between the rod and lantern and practically clamped the lantern on the rod.

When the lantern had finally been removed from the rod, the engineer turned his attention to removing


Bushing inserted here
Bushing jammed on Rod at this End carrying the Lantern to the Bottom of the Stuffing Box at each up Stroke.

STUFFING-BOX FOR AMMONIA COMPRESSOR

the rest of the packing that should be above the lantern in the stuffing-box. To his surprise there was not a shred of it left. The reason for the pound or knock was now plain to him. With no packing in the top half of the stuffing-box and the lantern jamming hard on the rod at the crank end, the lantern had struck the bottom of the stuffing-box at every up stroke of the compressor, and of course the knock resulted.

The engineer was at first badly puzzled to account for the disappearance of the packing above the lantern, but when the rod was again inserted, he found that there was nearly $\frac{1}{8}$ in. clearance between the rod and the neck of the stuffing-box. The rod had been turned down some time previous to this, and no provision had been made to make up for the reduced diameter. This was now provided for by making a junk ring $\frac{3}{4}$ in. thick and a snug fit in the stuffing-box and $\frac{1}{32}$ in. larger inside diameter than the rod. This was slipped over the rod and placed at the bottom of the box. It prevented the packing from working out between the rod and the neck of the stuffing-box and ended the trouble with this stuffing-box as well as eliminating the puzzling knock.

Future Location of Central Power Stations

By DEVER C. ASHMEAD

The coal mines are able to produce all the coal required, but the transportation facilities are not adequate; therefore, it is suggested that the country be divided into districts, each served with electric power generated by central stations located at the sources of fuel supply. The advantages of the plan are outlined, and estimates of the probable saving are given.

THE fuel problem does not lie in the inability of the mines to produce the coal, but rather in the inability of the railroads to transport it. The matter is one of transportation instead of production. The country requires 600,000,000 tons of coal per year, and the mines can furnish 750,000,000 tons in that time; but the railroads cannot handle more than 550,000,000 tons a year, or 50,000,000 tons less than the normal demand.

The failure of the railroads to handle the required quantity of coal is due to three factors: First, lack of motive power; second, shortage of cars; and third, delay of the consignee in unloading cars. This article is not concerned with the last of the foregoing causes, but it is vitally concerned with the other two. Any practicable method of relieving the shortage of locomotives and cars must be of interest to the whole country; therefore, it will be advisable to investigate at least one phase of the situation.

Increase in Use of Electrical Energy

According to the United States Census Reports, the electrical energy generated in 1907 is estimated as 10,621,407,000 kw.-hr., and in 1912 as 17,585,622,000 kw.-hr. In 1917, according to careful estimates, over 27,000,000,000 kw.-hr. was sold by central stations, which is 16,378,593,000 kw.-hr. more than was generated in 1907, or an increase of approximately 155 per cent. in ten years. It is realized that the figures for 1907 represent current generated and those for 1917 represent current sold, so that they are not strictly comparable. However, the amount of energy generated in 1907 is not obtainable; and furthermore, if losses were included, the value 27,000,000,000 kw.-hr. would be considerably increased. This increase would serve only to strengthen the argument put forth in this article; consequently, the two values are compared as shown.

It is not unreasonable to assume that in the next ten years the use of electricity will increase in the same ratio, which means that in 1927 the output would be 68,850,000,000 kw.-hr. About one-third of the electrical output in 1917 was produced by hydro-electric plants; therefore, at the same ratio, 46,000,000,000 kw.-hr. would be generated by steam in 1927. It requires from 2 to 10 lb. of coal to produce a kilowatt-hour. If an average of 3 lb. is assumed, which certainly is conservative enough, it follows that the 18,000,000,000 kw.-hr. produced in 1917 required 54,000,000,000 lb. of coal, or 27,000,000 short tons.

To handle this tonnage, the railroads had to move 675,000 carloads of coal averaging 40 tons to the car. By 1927 these figures will have increased to 138,000,000,000 lb. of coal, or 69,000,000 short tons; and estimating 50 tons of coal to the car, since by that time all the small cars will be scrapped, there will be 1,380,000 carloads.

In 1917 there were approximately 950,000 coal cars in the United States and more than two-thirds of the number were required to make one trip from the mines to the power plants to furnish the needed coal. The money paid to the railroads for freight on this coal, taking a freight rate of $1.50 a ton, amounted to $40,500,000, which is interest at 5 per cent. on $810,000,000.

Assuming the same freight rate, producers of electricity in 1927 would pay the railroads $103,500,000 a year, which is the interest at 5 per cent. on $2,070,000,000. If the latter sum were used to develop the electrical industry, a wonderful advance could be made. It is advisable, therefore, to investigate the distribution of the use of electricity and its relation to the coal fields of the United States.

Generation of Power at Coal Mines

Table I gives the production of coal and coke in the several states in 1916. Table II shows the amount of current generated in the several states and the coal required to produce this current, in 1917 and 1927. The greater part of the electrical production is comparatively near the different coal fields, which naturally suggests the idea of generating current at the source of fuel supply instead of at the point where the power is used. In these days of high-tension electrical transmission over long distances, this suggestion has greater force.

As shown on the accompanying map, the writer divides the country into 23 districts, each supplied with electricity generated from one or more central stations, which are indicated by black dots. Table III gives the total kilowatt-hours and the quantities of coal to produce them in these districts, for both 1917 and 1927. Of course the actual working out of a plan of this kind would probably differ greatly from the districting here shown, but the latter will serve to illustrate the idea.

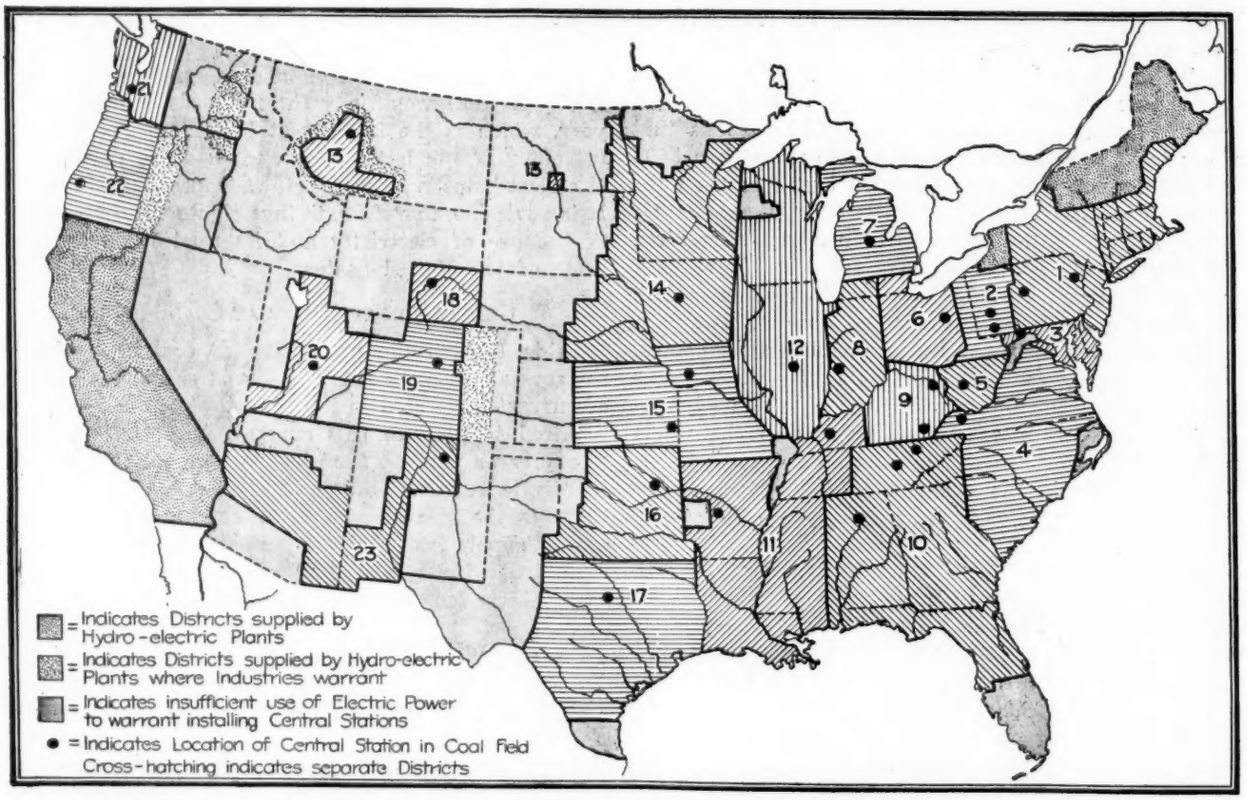
Objections to Plan as Outlined

The first objections to such a plan would probably be the cost of the necessary transmission lines and the loss due to the abandonment of existing central stations. Approximately 100,000 miles of transmission lines at about $15,000 a mile would be required, involving the huge sum of $1,500,000,000. Plants now in operation would be worth only their scrap value, which would entail a loss of another $1,500,000,000. Thus, the total investment required would be $3,000,000,000.

It was shown that the saving in the cost of transporting coal in 1917 would have amounted to $40,500,000, and that in 1927 it would amount to $103,500,000 if the power were generated at the mines. In Pennsylvania, 88,312,000 tons of anthracite was mined in

1916, of which 8 per cent. was too fine to ship. This 8 per cent., amounting to 7,000,000 tons, would generate one-fourth of the electricity used in the United States in 1917. This grade of fuel, which can be burned successfully on chain-grate stokers, could be flushed with water and pumped through pipes from the mines to the power stations, where the water could be drained off and the coal dried for burning. Such silt could be obtained at the central station for approximately 75c. a ton less than No. 2 buckwheat or bird's-eye coal at the mine, and its use would save $5,250,000 a year.

Another saving could be made in the coke regions. In 1916 approximately 37,000,000 tons of coke was produced from beehive ovens. Each ton of coke produced about 5 per cent. of coke breeze, or nearly



MAP SHOWING TENTATIVE DISTRICTING, WITH LOCATIONS OF CENTRAL STATIONS SUPPLYING VARIOUS DISTRICTS WITH POWER GENERATED AT MINES

1,900,000 tons, in 1916. Manufacturers of coke now pay to have it hauled away; but if it were sold for even 40 or 50c. a ton, replacing coal at $2.50 a ton, there would be a saving of about $3,800,000 a year to the fuel user.

Further saving would be effected by reducing the loss of coal in transportation, due to leakage, wrecks and stealing. This loss may run from 2 to 5 per cent. Taking the lower value, the loss in 1917 was 540,000 tons and in 1927 it would be 1,380,000 tons. Assuming a price of $2.40 a ton at the mine, the loss would be $1,300,000 in 1917 and $3,300,000 in 1927.

In mining bituminous coal by machines, an undercut about 6 in. deep is made, and the fine coal, or "bug dust," thus formed is about 8 per cent. of the coal mined, or 39,500,000 tons in 1917. Subtracting the 5,500,000 tons used in the production of coke, 34,000,000 tons remain, and if it were screened out of the coal and used for the production of power, the value of the remainder of the coal would be increased. If the saving amounted to only 10c. a ton, the saving in 1917 would be about $3,400,000.

Further saving would result from the more economical burning of fuel and generation of power, since electricity can be generated more cheaply in a large plant than in a small one. At present there is great waste of coal in hand-fired plants; much is wasted by the old types of mechanical stokers, and more is wasted by the use of unsuitable grates. The reduction of these losses would probably save millions. The reduction in cost of labor and supervision by substituting a few large plants for many small ones would also run into millions.

The various estimates that have thus far been considered may be summarized as follows:

	1917	1927
Tons of coal required for estimated kw.-hr	27,000,000	69,000,000
Freight paid to railroads	$40,500,000	$103,500,000
Saving by using anthracite silt	5,250,000	5,250,000
Saving by using coke breeze	3,800,000	3,800,000
Saving by using bug dust	1,750,000	3,400,000
Reducing loss of coal in transportation	1,300,000	3,300,000
Total	$52,600,000	$119,250,000
Equivalent principal, taking interest rate of 5 per cent	$1,052,000,000	$2,385,000,000

If the foregoing economies could be put into effect at once, the saving would pay the interest at 5 per cent. on more than a billion dollars, while in 1927 it would pay the interest on almost two and a half billions. These figures do not take into account the other savings mentioned. If their values were added, the total saving in 1927 would probably be more than enough to pay the interest on the required three billions of

investment. The feasibility of the scheme, from a financial viewpoint, is thus demonstrated. It remains to see whether it is practicable.

A careful study of Tables I and IV, in connection with the districts shown on the map, indicates that each district produces enough coal of the right grade or quality to meet its demand for power. Table IV gives the coal and coke production, by districts, in 1916.

TABLE I. PRODUCTION OF COAL AND COKE IN 1916, IN SHORT TONS

	Coal	Coke
Alabama	16,250,000	4,250,000
Arkansas	2,000,000	
California	12,000	
Colorado	10,260,948	1,320,000
Georgia	140,000	25,000
Illinois	63,500,000	2,500,000
Indiana	18,738,256	3,100,000
Iowa	7,600,000	
Kansas	8,000,000	
Kentucky	25,106,500	980,000
Maryland	4,930,000	395,000
Massachusetts		600,000
Michigan	1,056,393	
Minnesota		250,000
Missouri	4,000,000	
Montana	3,688,307	
New Mexico	3,893,185	479,153
North Dakota	620,000	
Ohio	30,500,000	725,000
Oklahoma	3,053,543	
Oregon	39,230	
Pennsylvania (bit.)	170,270,000	30,746,000
Pennsylvania (anth.)	88,312,000	
South Dakota	14,000	
Tennessee	6,589,915	275,000
Texas	2,300,000	
Utah	3,621,935	224,294
Virginia	9,300,000	700,000
Washington	3,000,000	140,000
West Virginia	87,989,000	1,900,000
Wyoming	7,650,000	2,300,000
	582,435,212	50,909,447

TABLE II. CURRENT GENERATED BY STEAM, AND SHORT TONS OF COAL BURNED, BY STATES

	1917		1927	
	Kw.-Hr.	Coal	Kw.-Hr.	Coal
Alabama	202,000,000	303,000	515,100,000	772,650
Arizona	8,000,000	12,000	20,400,000	30,600
Arkansas	63,000,000	95,000	160,650,000	242,250
California *				
Colorado	316,000,000	474,000	805,800,000	1,208,700
Connecticut	179,000,000	268,000	456,450,000	683,400
Delaware	39,000,000	59,000	99,450,000	150,450
Dist. of Columbia	179,000,000	268,000	456,450,000	683,400
Florida	78,000,000	117,000	198,900,000	298,350
Georgia	116,000,000	174,000	295,800,000	443,700
Idaho †				
Illinois	2,070,000,000	3,105,000	5,278,500,000	7,917,750
Indiana	700,000,000	1,050,000	1,785,000,000	2,677,500
Iowa	185,000,000	278,000	471,750,000	708,900
Kansas	142,000,000	213,000	362,100,000	543,150
Kentucky	229,000,000	343,000	583,950,000	874,650
Louisiana	163,000,000	245,000	415,650,000	624,750
Maine	100,000,000	150,000	255,000,000	382,500
Maryland	358,000,000	537,000	912,900,000	1,369,350
Massachusetts	1,200,000,000	1,800,000	3,060,000,000	4,590,000
Michigan	329,000,000	493,000	838,950,000	1,257,150
Minnesota	232,000,000	348,000	591,600,000	887,400
Mississippi	58,000,000	87,000	147,900,000	221,850
Missouri	772,000,000	1,158,000	1,968,600,000	2,952,900
Montana	17,000,000	26,000	43,350,000	66,300
Nebraska	147,000,000	220,000	374,850,000	561,000
Nevada †				
New Hampshire	62,000,000	93,000	158,100,000	237,150
New Jersey	640,000,000	960,000	1,632,000,000	2,448,000
New Mexico	9,000,000	14,000	22,950,000	35,700
New York	3,350,000,000	5,025,000	8,542,500,000	12,813,750
North Carolina	50,000,000	75,000	127,500,000	191,250
North Dakota	19,000,000	29,000	48,450,000	73,950
Ohio	1,459,000,000	2,188,000	3,720,450,000	5,579,400
Oklahoma	100,000,000	150,000	255,000,000	382,500
Oregon	293,000,000	439,000	747,150,000	1,119,450
Pennsylvania	1,895,000,000	2,843,000	4,832,250,000	7,249,650
Rhode Island	191,000,000	286,000	487,050,000	729,300
South Carolina	60,000,000	90,000	153,000,000	229,500
South Dakota	10,000,000	15,000	25,500,000	38,250
Tennessee	158,000,000	237,000	402,900,000	604,350
Texas	315,000,000	473,000	803,250,000	1,206,150
Utah	76,000,000	114,000	193,800,000	290,700
Vermont	31,000,000	46,000	79,050,000	117,300
Virginia	227,000,000	340,000	578,850,000	867,000
Washington	579,000,000	869,000	1,476,450,000	2,215,950
West Virginia	113,000,000	169,000	288,150,000	430,950
Wisconsin	349,000,000	524,000	889,950,000	1,336,200
Wyoming	18,000,000	27,000	45,900,000	68,850

* Coal consumption for generating electric power is practically nothing.
† Coal consumption for generating electric power is negligible.

Table V shows the length of transmission lines needed in each district.

The arrangement of the central stations is a matter of study for each individual district, but some suggestions can be made. In some districts it might be better to have a number of small stations located at the different mines and supplying power to a main transmission line. In the Indiana district, for example, the coal field is a long, narrow strip on the western border, and there are a number of mines with an output of 500,000 tons of coal a year each. A central station could be located at each of these mines and take its entire output, and each would produce about 330,000,000 kw.-hr. a year.

TABLE III. CURRENT GENERATED BY STEAM, AND SHORT TONS OF COAL BURNED, BY DISTRICTS

	1917		1927	
District	Kw.-Hr.	Coal	Kw.-Hr.	Coal
1	6,701,000,000	10,051,500	17,087,550,000	25,631,325
2	1,340,000,000	2,010,000	3,417,000,000	5,125,500
3	632,000,000	948,000	1,611,600,000	2,417,400
4	295,000,000	442,500	752,250,000	1,128,375
5	59,000,000	88,500	150,450,000	225,675
6	812,000,000	1,218,000	2,070,600,000	3,105,900
7	123,000,000	184,500	313,650,000	470,475
8	782,000,000	1,173,000	1,994,100,000	2,991,150
9	479,000,000	718,500	1,221,450,000	1,832,175
10	475,000,000	712,500	1,211,250,000	1,816,875
11	448,000,000	672,000	1,142,400,000	1,713,600
12	2,654,000,000	3,981,000	6,767,700,000	10,151,550
13	17,000,000	25,500	43,350,000	65,025
14	634,000,000	951,000	1,616,700,000	2,425,050
15	721,000,000	1,081,500	1,838,550,000	2,757,825
16	205,000,000	307,500	522,750,000	784,125
17	210,000,000	315,000	535,500,000	803,250
18	18,000,000	27,000	45,900,000	68,850
19	316,000,000	474,000	805,800,000	1,208,700
20	76,000,000	114,000	193,800,000	290,700
21	579,000,000	868,500	1,476,450,000	2,214,675
22	293,000,000	439,500	747,150,000	1,120,725
23	17,000,000	25,500	43,350,000	65,025

Another example may be found in the anthracite field. There might be three large central stations, one in each part of the field. As these plants could burn silt and fine coal, their fuel could be pumped from the various breakers to the central plants, relieving the railroads from handling it.

Still another example is the eastern Kentucky field, containing three main railroad lines on which the coal is produced. It might probably be best in this field to have three main power plants, one on each of the three railroads.

TABLE IV. COAL AND COKE PRODUCTION IN SHORT TONS, IN 1916, BY DISTRICTS

District	Coal	Coke	District	Coal	Coke
1	128,312,000	2,600,000*	14	7,614,000	
2	149,270,000	28,746,000	15	12,000,000	
3	4,930,000	395,000*	16	3,053,543	
4	33,300,000	2,600,000	17	2,300,000	
5	44,989,000		18	7,650,000	2,300,000
6	30,500,000	725,000*	19	10,260,948	1,320,000
7	1,056,393		20	3,621,935	224,294
8	18,738,256	3,100,000*	21	3,000,000	140,000
9	11,000,000	980,000*	22	39,230	
10	22,979,915	4,550,000	23	3,893,185	479,153
11	16,106,500			582,423,212	50,909,447
12	63,500,000	2,750,000*			
13	4,308,307				

* Byproduct coke.

In the bituminous field it would probably be better to have a number of smaller plants located at convenient points, so that the slack coal would need to be carried a minimum distance by the railroads. Such a plan would be better than having one or two large plants, as the latter would involve a longer haul.

TABLE V. LENGTH OF TRANSMISSION LINES, BY DISTRICTS

District	Miles	District	Miles
1	14,300	15	8,500
2	5,900	16	4,000
3	1,800	17	4,000
4	6,700	18	600
5	2,100	19	2,000
6	4,800	20	1,000
7	4,000	21	2,000
8	6,300	22	1,000
9	2,500	23	3,000
10	9,500		
11	8,500		123,300
12	15,500	Less 21, 22 and 23	6,000
13	1,000		
14	14,300		117,300

It has been shown that electric companies and users of power would benefit by electric-power generation at

the mines. Now it remains to be shown how the railroads would be benefited by the reduction of the burden of transportation. In 1915 there were about 900,000 railroad cars in use in the United States for hauling coal, and 344,119,502 tons were hauled. At 40 tons to a car, there was a total of 8,602,988 carloads, so that each car made 9½ trips a year from the mines to the consumer. As there were 675,000 cars of coal handled in 1917 for electric plants alone, it was necessary to keep about 71,000 cars in this service. In 1927, assuming the same number of trips per car, but 50 tons to a carload, there would be 1,380,000 carloads, requiring 145,000 cars. The locomotives needed to handle these cars, assuming 50 cars to a train in 1917 and 60 in 1927, would be 1400 in 1917 and 2890 in 1927. The reduction in the amount of coal handled, by generating the power at the mines, would be enormous. Of course the revenue from the freight on this coal would be lost to the railroads, but the equipment thus released could be turned to the carrying of other commodities, so that their income would not necessarily be affected adversely.

Precedents for Long-Distance Transmission

At the present time there are a number of precedents for the long-distance transmission of power and for the establishment of central stations at the source of the fuel supply, and it might be well to show what has been done. A number of examples of long-distance transmission of power exist in the West, particularly in California, one of the most noteworthy being that of the Stanislaus system. This is a hydro-electric plant in the Stanislaus Mountains. It has a capacity of 100,000 kw. and transmits power at 110,000 volts to San Francisco, more than 150 miles away. This plant has been in operation since 1907.

There are a number of plants east of the Mississippi River which have their central stations at the mines and distribute power over a considerable extent of territory. The Rochester & Pittsburgh Coal Co., at one of its operations in Indiana Co., Penn., transmits power for a distance of about 30 miles at 22,000 volts. This plant is typical of those which use waste fuel, as it burns bone coal. Such coal is commercially worthless, due to high ash content and lack of luster, but it has to be removed from the mines. This plant has an installation of 12,000 kilowatts.

At Cabin Creek Junction, W. Va., the Virginia Power Co. has installed a plant of 20,000-kw. capacity and arrangements have been made to increase it. Current is transmitted at 44,000 volts to hundreds of coal mines within a radius of 50 miles and the company is now considering extension of the lines.

At Hauto, Penn., a plant of 37,500-kw. capacity, which is to be enlarged to 100,000 kw., has been built by the Lehigh Coal and Navigation Co. The current is transmitted at 110,000 volts for distances up to 50 miles. The plan is to extend the lines eventually to New York and Philadelphia, 98 and 73 miles away, respectively. This current is used to supply a large number of mines and manufacturing plants, and a very small grade of coal is used.

Near Wilkes-Barre, Penn., the D., L. & W. R.R. at its Loomis mine has an installation of 10,000 kw. and transmits the current at 22,000 volts to a number of mining operations. Silt is used for the generation of steam.

At Peoria, Ill., there is a central station with a capacity of 10,500 kw. supplying a population of 140,000 people in five counties having 27 cities and towns. Two mines very near the central station furnish the coal, and the current is transmitted at 33,000 volts.

The Christopher Coal Mining Co., Christopher, Ill., has an installation of 5000 kw., and all the surplus power is stepped up to 33,000 volts and supplied to a public-utilities company.

The Kentucky Utilities Co. has a plant in the Pocket near St. Charles, Va., and another at Varilla, Ky. The Pocket plant is of 10,000 kw. and the Varilla plant of 5000 kw. The Varilla plant is supplied with coal by a company whose tipple is about 500 ft. away, while the Pocket plant is supplied by the coal mines at St. Charles and the washer at the Pocket. These plants are connected by more than 50 miles of transmission lines, and they supply a territory more than 150 miles long, which is being extended monthly; 33,000 volts is used for the transmission of the current.

The Clearfield Bituminous Coal Corporation has a 2000-kw. plant at Clymer, Penn., and a 5000-kw. plant at Rossiter, Penn. The Clymer plant is tied in with the Pennsylvania Public Service Corporation lines, and the one at Rossiter is about to be. The service corporation supplies a number of counties in the central part of Pennsylvania with 22,000-volt current. At present the lines are more than 150 miles long and are being extended.

Packing Water-Pistons of Pumps

Packing the water end of an internally packed pump is considered a comparatively simple job, but the life or service of the packing is greatly influenced by the way it is put in and adjusted. The one big requisite is that the packing be pinched or clamped firmly between the flange and the follower plate. When so clamped, it can withstand the action of the water without being washed away. This is especially noticeable when the pump cylinder has become worn large in the middle so that there is more or less water slip toward midstroke. If the packing is not solidly gripped, it will not stay long, will be washed away; if, however, it is held as in a vise, it will withstand the erosion and "tugging" effect a much longer time.

The packing cannot be expected to expand to suit the worn part and compress to pass into the smaller portion at the ends, as the rings in the steam end do, and still last a reasonable time, because of its fibrous nature.

A split ring should be put in, if necessary, just ahead of the last ring so that the packing will extend slightly beyond the plunger and the follower plate will pinch it hard before coming against the face of the plunger.

By doing without needless luxuries you can save money. And by investing that money in War Savings Stamps, you automatically release to the Government the labor and material that it needs for winning the war. The Government doesn't ask you to give your money, or to do without luxuries forever. Uncle Sam simply wants your game of pleasure and luxury postponed on account of the rain of bullets that the Huns are directing at our fighting lads.

Editorials

"We'll Stand Fast"

Words of Inspiration from "Power's" Paris Correspondent

IN THE world crisis precipitated by the German onslaught in Picardy and Flanders the faith of France in her own armies and those of her allies remains absolutely unshaken. This is the clear-cut impression gained by the observer in Paris today. There is no panic here as Teuton propagandists would have the world believe, nor are there discernible even the symptoms of a general uneasiness.

Long-range shelling by day, bombing raids from the air by night, and the threat of a German advance upon the French Capital, far from demoralizing the spirit of the civil population, have lifted it to new heights of determination and confidence. The daily news from the front is even more encouraging, and there are just beginning to drift back hints of the heroic part which the engineers of the allied forces are playing in the greatest war drama of all time.

When the full story is told of how they have been performing day after day seemingly impossible feats in transporting reserve troops and material and in maintaining lines of communication, it will form the grandest epic in the annals of engineering.

From the picture of public feeling here I will pick out a single detail. At the *pension de famille,* where I stay, lives the aged widow of a French general. Amid the bursting shells of the long-range gun, bombs dropped in the night and early rumors of an overwhelming German attack, her friends attempted to persuade the old lady to leave Paris. I saw her eyes flash, her bent shoulders straighten back, and as she snapped, "*Je reste ici,*" she seemed to embody in those three words the spirit of France—"We'll Stand Fast."

Mine-Mouth Generation of Power

THE plan outlined in the article on page 661 of this issue suggests locating large electric power stations in the heart of the coal-mining districts of the country, generating electrical energy there and transmitting it by high-tension lines to the points where power is required. The idea is not a new one, for it has been put forth, in one form or another, in times past. But the exigencies brought about by war conditions lend fresh emphasis to the proposal.

It is at once apparent that the utilization of coal for power generation at the mine does away with the necessity of transporting that coal to distant points and so relieves the railroads of a vast amount of tonnage. So far as the past season is concerned, the congestion of traffic on the railroads was due to lack of motive power to handle the increased quantity of freight. Obviously, any arrangement by which a large percentage of the freight traffic could be eliminated would afford a solution of the transportation problem.

The large power plant is capable of producing energy at a lower cost than the small plant working under like conditions, so that the plan proposed has the additional advantage of economizing in the use of fuel. This, too, has been brought prominently into notice of late.

The author, for the purpose of presenting his argument, divides the country into a number of districts, each of which contains one or more coal fields of sufficient size to furnish the power for that district. The division shown is made arbitrarily, and any definite attempt to put such a plan into operation would probably alter the boundary lines considerably.

The current generated at the district central stations is transmitted to various parts of the district by high-tension transmission lines. The lengths of these lines in some cases would be great, but there are a sufficient number of long-distance transmission lines now in operation to furnish the necessary precedents.

A further step, not mentioned by the author in his discussion, would be the recovery of byproducts from the coal before it is utilized as fuel. This point is now under consideration in Great Britain, in connection with a plan to divide that country into some sixteen districts, each containing electric generating stations as centers of supply of power. The idea is to build the by-product plant in close proximity to the power plant and to extract from the coal all desirable byproducts before using it to produce heat for power, where such extraction proves justifiable.

All these plans for the utilization of the greatest possible percentage of the value of coal are straws showing that the trend of modern engineering is in the direction of greater efficiency and increased conservation of natural resources.

The Coal Situation

THE problem of supplying every coal consumer in this country with sufficient fuel to meet his needs for the coming winter hinges entirely on transportation, and the Fuel Administration gives assurance that there are enough cars and locomotives to transport the necessary quantity of coal, provided that every car and every locomotive are used to their maximum capacity every day in the year. Also, there are enough mine workers to furnish the required output, if they are kept busy every day in the year and if the cars and locomotives are available.

The full coal-carrying capacity must be utilized all the time, and to attain this end it is necessary that the coal operators be supplied with orders. If orders are delayed, or are small, the output at the mines will be curtailed correspondingly, resulting in idle workmen; but still worse, the number of coal cars delivered to the mine will be reduced to suit the demand, and coal-carrying equipment will be idle.

There is no elasticity in the transportation of coal. The movement must be continuous and always at full capacity, if a fuel famine like that of last year is to be averted. The aggregate demand for coal is so great that a slump in production during a week or a month cannot be made up in a succeeding period.

The Fuel Administration is doing everything in its power to keep all the machinery for the production and distribution of coal working at maximum capacity. The reduction of thirty cents a ton to the domestic consumer is made in the hope that orders for the winter's coal will accumulate to such an extent that both the mines and the railroads will be kept busy continuously throughout the year.

The producer is not able to mine the coal and store it in anticipation of a future demand. Few mines have storage space or equipment; and even if these were available, there would be an unnecessary expense incurred in the double handling of the coal. The most economical and rapid method is to mine the coal, load it directly into cars and ship it to the points where it is to be used, there to be stored until it is needed.

The Fuel Administration will coöperate with any community that desires to provide storage for emergency stocks of coal to be laid in during the summer months; but the greater part of the storage capacity of the country is made up of the bins of the individual consumers, and these are the logical places for the accumulation of stocks of fuel.

The Government has established a schedule of fixed prices for coal at the mines; it has put into effect a zone system of distribution to facilitate transportation; it encourages the production of clean coal by allowing higher prices to producers who take extraordinary pains in preparing their output; and it penalizes in price those coals that contain undue amounts of foreign matter. In view of these measures the prompt and complete coöperation of the consuming public by the placing of orders is needed to insure the successful distribution of the year's coal.

Home Army Must Supply Power

THERE are two fields of battle in the war against German autocracy and militarism, and to win the war we must conquer on both those fields. One is in France and Belgium and extends from the North Sea to the Swiss border. The other is here in America. It extends from the Atlantic to the Pacific and from the Canadian border to the Gulf of Mexico. It covers every city, town and village, every farm, field and woodland in the country.

In France our soldiers, standing shoulder to shoulder with the British, French and Italians, repeat the great French battle cry of Verdun, "You shall not pass!" Their breasts are a wall of steel against the charging masses of the Kaiser. Amid the roar of cannon, the rattle of machine guns and the clash of bayonets, they stand firm.

Over here it is the noisy clang of the riveters in the shipyards, the busy hum of the factory, the whirring wheels of smoothly running engines, the silent efficiency of the great office force, the push of the plow in soft earth and the swift stroke of the woodman's ax.

All are fighting in the great battle that democracy may live—those whose part is played here, as well as those who sail across the sea to offer their lives in France. And it is as essential for final victory that the army here shall stand firm—the army of workingmen and workingwomen—that no part of the long line shall give, that every man shall put forth the last ounce of his strength, that they shall fight with their backs to the wall, as it is that that line in France shall hurl back the German hordes. For our men over the sea cannot win without us at home. They look to us to back them up, to keep a steady stream of men and munitions and supplies of all kinds crossing the Atlantic, to build the ships that will bridge the ocean.

Our duty is as stern as is that of the soldiers in France, and our fate is as unrelenting. Our choice is unremitting labor and unquestioning, willing sacrifice, or defeat and subjugation to the iron despotism of Germany. There are no other alternatives.

The Third Liberty Loan campaign is ended, and the loan well oversubscribed. The response of the people of America has been more than equal to the present demand. They have done well, but this is not all. Let us now concentrate our energies to putting the War Savings Certificates over the top, for they are also a liberty investment that our Government is depending upon to provide the sinews of war. The line on the battlefields of America must not waver, so that the line in France will hold firm, because our men in France put their faith in us in America. Let us not fail them. Let us be equal to any call that is made upon us. Let us now buy War Savings Certificates to the limit of our resources, and then strain our resources to buy more Government securities. In that way lies victory.

Boilers not built in conformity with the Code may be carried into Pennsylvania, but may not be operated, according to an opinion recently rendered by the Attorney-General's Department to the Department of Labor and Industry. The board had ruled that boilers not built in conformity with its boiler code may not be brought into Pennsylvania. The Legal Department is of the opinion that such a ruling cannot be enforced, but that the board can prevent the operation of the boiler until it is made to conform with its code.

Which will you choose? The Government needs all the money, material and labor it can get, and more. This is a war of equipment. No matter how brave our men are, they cannot face the greatest military organization the world has ever known with bare hands. There is not enough labor and material in the country for our usual comforts and luxuries and for our fighters' necessities. We must choose which it shall be.

There's an old saying that it's better to have tried and failed than never to have tried at all; but while it may be right to look at some things in that way, it cannot be applied to all tasks and problems that one meets with in the power-plant field. Overconfidence in one's ability will as surely bring failure as would lack of sufficient courage to tackle the job.

Farley G. Clark, of Niagara Falls, N. Y., proposes to pump coal from mines to centers of consumption through pipe lines. The idea is worthy of study.

Correspondence

Meeting an Emergency

The plant of which I have charge supplies light and heat to a large railway terminal hotel, station buildings, etc. We have two boilers, but use only one at a time, the other being kept clean and ready to fire up at a moment's notice. We burn oil pumped directly to the burners from the underground storage tank, which is about 200 ft. from the boiler room. One 3 x 2 x 4-in. duplex pump is used at a time, supplied from a common 3-in. suction line. This line comes out of the tank above the level of the pumps, drops considerably below their level, then rises through the boiler-room floor to the pumps after making a number of right-angled turns. The pumps run very slowly, controlled by a governor, to supply the oil as fast as it is burned. We have no trouble as long as the oil tank is not less than half full, as the oil is above the level of the pumps; but below this the pump frequently loses the oil, and it is sometimes difficult to get it to pick up again.

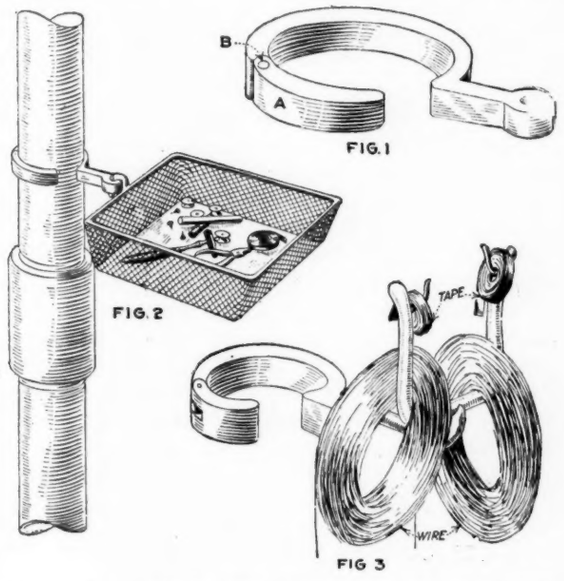
Recently, I had a new man on the midnight to 8 o'clock shift. He had specific instructions what to do and how to manipulate the pumps in case they lost the oil, and was told to call me in case of trouble. One morning about 3 o'clock the pump lost the oil and the man evidently lost his head altogether, for when I got to the plant the fire was out and the steam down to 20 lb. The dampers were wide open, allowing a cold draft through the boiler. The engine was running with full load on, though at such reduced speed that the lights could barely be seen. I shut down the engine, closed the damper and cut out a live-steam heating circuit. By this time the steam was down to 15 lb. I started the spare pump, which was in perfect condition, but the steam was too low to run the pump fast enough to pick up the oil. The case seemed hopeless. There was no means of raising steam except with oil and steam of at least 30 lb. pressure was required to pump the oil. It was very cold and impatient inquiries were coming in thick and fast; so I disconnected the pump suction pipe, put in a tee, then a nipple and valve, and in the valve I screwed a piece of 3-in. pipe about 3 ft. long. I then attached ropes to two pails, and with these we drew oil from the tank, carried it to the boiler room and filled the suction line and pump through my improvised standpipe. By that time there was only 10 lb. of steam pressure, barely enough to move the pump and atomize the oil in the burner. I certainly felt relieved when the gage on the oil line to the burners showed pressure enough to start the fire. We kept carrying oil until we had 40 lb. steam and succeeded in getting the pump to take oil from the tank. In an hour from the time I arrived we had the full load on the engine and steam heat on in all departments.

This incident convinced me that in all oil-burning plants the burner pump should take oil from an overhead tank, so I am installing a small overhead tank to be kept filled by piping the discharge oil from the overpressure valve, on the oil line between the pumps and burners. From this overhead tank I will run an overflow pipe to the storage tank instead of the present layout where the overflow pipe runs directly back to the storage tank. From the bottom of this auxiliary tank I will run a pipe to the pump suction line so that it will only be necessary to open a valve to prime the pump, since the overhead tank will always be kept full by the discharge from the overpressure valve.

Ash Fork, Ariz. W. G. CAMP.

Easily Attached Toolholder

The bracket shown in Fig. 1 is made of machine steel and hardened on the corners for gripping on pipes or poles for holding the tool basket, Fig. 2, or the wire and tape holder, Fig. 3, thus enabling the electrician to have



FIGS. 1 TO 3. PARTS AND ASSEMBLY OF TOOLHOLDER

everything within easy reach. The part *A*, Fig. 1, is hinged to give access to the pipe or pole. The rivet *B* is made tight enough to keep the part *A* closed when the bracket is in place. M. P. BERTRANDE.

Ozone Park, N. Y.

A Suggestion to Advertisers

Although the pages of *Power* are interesting from the front to the back and are full of useful information, there is one thing more your advertisers might do (some do it now but others do not); that is, to mention their representatives in the principal Canadian cities. We have often written to advertisers only to be referred by them to a firm within a hundred miles of here.

Granby, Que., Canada. J. DRUMMOND.

Starting Synchronous Motors

In Mr. Gray's article, "Starting Synchronous Motors," in the Mar. 12 issue of *Power*, it is stated that when an attendant was not at hand to help the operator put the motor in service he tied the starting lever on the compensator in the starting position and then threw in the oil switch at the switchboard.

Some time ago I worked in a plant where there were two large synchronous motors with a similar starting equipment to that described by Mr. Gray. In starting the machines, we first closed the oil switch at the switchboard and then went to the compensator and threw it to the starting position. When the motor had come up to speed, the compensator was closed to the running position, after which the operator went to the switchboard, closed the field switch and made the necessary adjustments.

This may not be any better way of starting the motor than Mr. Gray's, but it seems to be somewhat simpler.

D. G. SIMMONS.

Beaver, Penn.

Snifting Valves on Pumps

By inference from the letter by A. L. Haas, on page 410 in the issue of Mar. 19, it would seem that it is the practice in England to fit snifting valves to pumps of all kinds to admit a small amount of air at each suction stroke. If this is the case, I am wondering what effect is observed in the boilers from this introduction of air. We are in the habit of believing that air (oxygen) in water is a fruitful cause of pitting in pipe systems and boilers, and often considerable trouble and expense are incurred in eliminating it, as against this deliberate introduction. Then again, if the plant is operated condensing, the extra air has to be got rid of from the condenser at the cost of power, not to mention the other mischief it does.

If the entrained air is drawn out at the air chamber or elsewhere before it gets beyond the pump, it would seem to be a useless expenditure of power to compress any small amount of air and then discharge it. Surely, a pump should operate right without snifting valves.

New York City. J. LEWIS.

Compressed Air for Cleaning Motors

In the issue of *Power* for Mar. 12 appeared an article by D. R. Shearer, on "Compressed Air for Cleaning Motors." The following on the same subject, but on somewhat broader lines, may be of interest. As it is often necessary to clean equipment carrying potentials of 2300 volts and lower, it is advisable to safeguard the operator as well as the apparatus. The nozzle of the cleaning tool should, therefore, if of metal, be well insulated with cambric and friction tape, otherwise short-circuits may occur between ground and live parts or live parts of opposite polarity. In any case the operator may be subjected to danger of shocks. A nozzle made of one of the insulating compounds now on the market is satisfactory, but should have a metallic lining on account of the erosive effect of high-velocity air.

An air line should be allowed to blow off for several minutes before the nozzle is placed near the insulation. There is usually oil and dirt and often water in the tank or pipe line, and if this is not blown out into the air it may be blown into the insulation of the machine, covering the windings with oil and dirt, both of which are conducive to short-circuits and grounds. The dirt, moreover, at high pressures such as 100 lb. per sq.in. may be forced into the insulation and cause failures.

Mr. Shearer recommends an air pressure of 100 lb. per sq.in. This pressure is too high for most cases, for blowing out rotary converters, generators and motors—a pressure of 60 to 80 lb. is the maximum and should not be exceeded. At 100-lb. pressure, with the nozzle close to the insulation, pieces of grit are easily forced into the insulating materials. On old apparatus or that which has carried heavy loads, the insulation has a tendency to rise up from the conductor, causing air bubbles; high-pressure air blows these open, tends to fray wrappings and may even blow pieces of insulation off entirely, while always tending to crack the insulating varnishes. A pressure above 70 lb. per sq.in., unless the nozzle is held at least 6 in. away from the insulation, is, in my opinion, a dangerous practice.

Every compressed-air tank should be fitted with a pressure gage and a safety valve. The air pressure should preferably be automatically controlled; that is, the air compressor should automatically shut down when the safe working pressure is reached.

Where 500-volt direct current is available, as it is in all rotary-converter railway substations, I have used discarded air compressors from street cars. These outfits occupy about one foot in height and a floor space of about one and one-half by two feet. They are automatically controlled, and the series motor is started direct from the line without the complication of starting resistance.

These sets, although small, answer the purpose for an 8000-kw. station provided a fairly large tank is used, are economical of space and are of low cost.

Chicago, Ill. R. K. LONG.

License Internal-Combustion Engine Operators

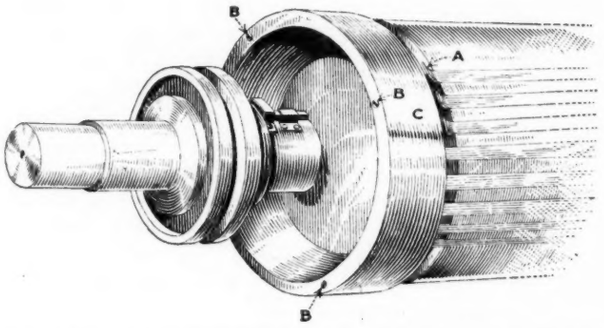
I am a licensed steam engineer and machinist, and also run gas and oil engines and have had several years' experience in testing, erecting, etc., in the gas- and oil-engine business. It has often occurred to me that there should be some way provided for gas engineers to secure a license that would show their proficiency. It seems to me that it would be profitable to all concerned, when understood. The engineers would get their license and possibly more pay, and last, but not least, the employers would know how to get competent men.

The safety departments do not seem to think it necessary to license gas-engine operators, but these men should know as much about lining up engines, setting valves, adjusting bearings, etc., as the steam engineer. I believe that there are a large number of operators that would be glad to avail themselves of such an opportunity. I would like to have an expression of opinion on this matter from the readers of *Power*.

Philadelphia, Penn. T. A. MARSHALL.

Accident to Turbo-Alternator

We have been hearing considerable about turbine and turbo-alternator failures during the last year or so. The following is a description of a peculiar accident that happened to a 2000-kw. 3600 r.p.m. 2200-volt two-phase alternator, causing a heavy explosion and completely burning out the field and armature windings of the machine. One of the steel end shrouds on the rotor became loose and worked endwise sufficiently to



PART OF ROTOR SHOWING HOW END SHROUD WORKED FORWARD

allow the ends of the brass wedges in the slots to bend out by centrifugal force and cut through the winding of the stator. From all appearances the cutting of the armature coils was gradual and no damage was done until one of the wedges was broken off and thrown into the windings, this doing the final damage. There appeared to be two explosions coming very close together, probably caused by one phase winding being short-circuited slightly before the other. The figure shows how the end shroud *C* worked endwise, allowing the brass wedges *A* to bend out by centrifugal force and finally break off and fly into the stator winding. *B* and *B* are small screws that were threaded into the polepieces to help hold the ring in place.

Herkimer, N. Y. H. G. BURRILL.

Improvement in Boiler Economy

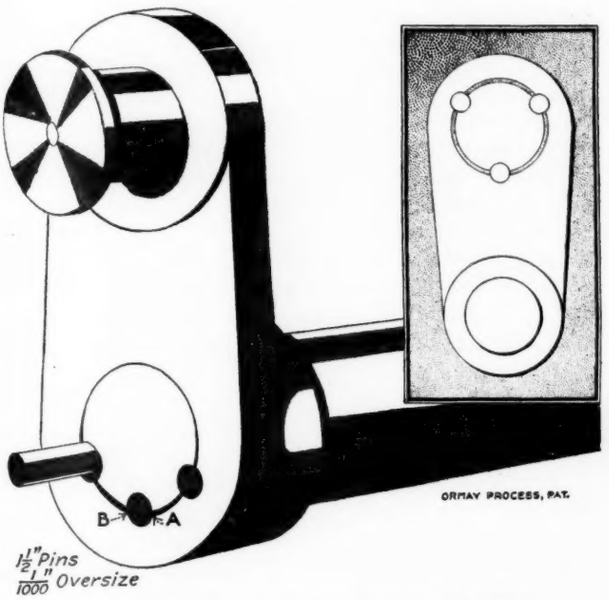
I am not an engineer, only a boiler operator, but the following may be of interest to readers of *Power*. I once had charge of three return-tubular boilers for over four years. When I took charge of them they were burning from eight to nine tons of coal a day on the high-pressure boiler and eight tons on the low-pressure boiler, only two in operation at a time in the winter season. I got busy trying to improve things after looking the situation over. The boiler settings were full of air leaks. In the back end you could throw a dog through, and there was no insulating covering on the boiler tops and no way to clean the tubes. Inside they were coated with scale from $\frac{1}{8}$ to $\frac{3}{4}$ in. thick.

I went to the general manager and told him if he would permit me to make some changes it would make a large saving in coal. He told me that if I could do anything to save coal to "go to it" and that he would get me whatever was needed. I relined the fire wall in the fireboxes, put in new door frames and new grates and patched up the other parts of the boiler settings. We got a new feed pump, and I made a tight wooden top for the water tank and piped the pump exhaust into the tank, and the returns from all steam lines were also piped back to the tank. They had been running into the sewers for years. This was a big saving for we used city water through a meter. I then got busy inside of the boilers with a pick and hammer and got rid of the scale, so I made a saving of eight tons of coal a day, and the whole thing cost only $250, feed pump and all. M. V. B. POTTS.

Massillon, Ohio.

Fastening a Loose Crank

On page 264 in the issue of Feb. 19 there are illustrations, at the lower part of the page, of what I, and others, consider the wrong method of trying to make a loose crank tight; for it is plain that the looseness of the crank is divided all around the shaft (purposely shown exaggerated in the illustration) and that the taper pins have the load and strains to carry. In other words, the shaft supports the pins and the pins the crank; while, if the job was done as shown in the illustration herewith, the lost motion or looseness would be taken up all in one direction and the crank would fetch up against the shaft for nearly half of its circumference, would have a perfect grip and would retain the original alignment; and the pins would only be called on to hold it in position. I have fixed several in this way and none that I have heard of has worked loose. I have also refitted two that someone had pinned



LOOSE CRANK PINNED ON ONE SIDE ONLY

all the way round. I do not make taper holes or pins, but make the pins about one-thousandth of an inch larger than the holes, and drawfile them on two sides at the points *A* and *B*. I pack the pins in ice before driving, but do not always heat the crank. I make the pins about three inches longer than I expect to use, mark the point on them to show when they are "home" and also make some sort of vent to let the air out of hole. I do not grease the pins, but drive them with a battering ram made of a piece of shaft hung by a rope block.

Exeter, N. H. L. JOHNSON.

Watch Your Step!

During the last quarter of a century much has been said and done in the field of industrial management, and the managerial mechanism developed has proved beyond doubt that it is nothing but a mechanism and as such may or may not produce the desired results, depending on how and by whom this mechanism is used. The management of power plants drags in the tail of the procession probably for two reasons: First, belief in the fallacy that good equipment necessarily produces good results; second, because financial interests consider the cost of power an insignificant item of the total expense. When, however, we feel the pinch of the shortage of fuel and when this shortage not only enhances the cost of power, but endangers the very existence of the various industries, even the health and well-being of communities, these fallacies must be disposed of at once.

It is not the equipment and supplies that produce results, but the mode of their use. When this is realized, two problems present themselves to power engineers: First, to secure mechanism for modern management; and, second, to make proper use of it. The success of a managerial mechanism involves certain responsibility by plant owners, since it is obviously their task to provide the plants with the means to study the causes and effects, to standardize and to keep adequate and dependable records. This in turn involves the education and training of the employees to make proper use of the available knowledge. Furthermore, they must have permanent and sufficient incentive for learning and living up to the better way taught them by the expert management. Under such conditions the executive is relieved of all the worries as to routine details, as these are standardized and can be well taken care of by subordinates. The major part of the time of the executive may thus be devoted to solving special problems and inaugurating improvements.

The results accomplished in the plants that have adopted these principles are permanent since they are worked out from the bottom up, and the economy accomplished varies all the way from 15 per cent. to 50 per cent., depending upon the conditions originally found in the plant.

To meet the present contingency both as to men and fuel, the first thing to do is to put the house in order after a thorough study, so that the methods may be based on facts, not on opinions and traditions. When this is done, enough room will be found in which to build up efficiency without resorting to "better equipment" and a lot of patent cures.

New York City. WALTER N. POLAKOV.

The Engineers' Unions

I have read with interest the few letters which have "passed the censor" and have been published in *Power* recently, in regard to engineers' unions, and wish to express, briefly, a few of my sentiments on the subject. I have been a member of one such union for years and must disagree with the statement by Mr. Dye, in the issue of Jan. 1, 1918, that anyone can get into the union and suggesting that candidates be examined.

Before I was accepted, I was required to produce my license to prove that I was an engineer, and in order to get that license I had to undergo a rigid examination. The possession of that paper was good evidence that I was an engineer without the necessity of any further examination on the part of the union, but I was also examined orally by a committee in a thoroughly practical way.

Personally, I have never been directly benefited through being a member of the engineers' union, but indirectly I have, as I am in the Federal service and it is a fact that it was primarily due to the activities of union labor among the Senators and Congressmen that Congress was induced to pass the eight-hour law, which limits the hours of labor of Government employees to eight hours in twenty-four, with one day off in seven and an annual vacation and sick leave on full pay. At present union labor is working very hard for a substantial increase in the wages of Government employees to offset in part the increased cost of living, and from all indications it will be granted. This will affect engineers as well as other employees in the Government service.

The Government as an employer does not recognize unions as an organization except in a few cases such as the navy yards. It is a fact that the lower-paid Government employees, clerks and mechanics who were until a year or two ago unorganized, had not had an increase in wages for many years until Congress in 1917 granted a temporary increase of from 5 to 10 per cent. for one year only, an inadequate increase in the face of the present conditions. But largely owing to the activities of the Federal Employees' Union coöperating with the heads of the various departments, a bill has been introduced in Congress to grant an increase of from 30 per cent. on the salaries less than $1000 to 5 per cent. on salaries up to $2500 per annum, in consideration of the present high cost of living.

Referring again to the engineers' case, if there are no state laws requiring engineers to take an examination and secure a license to operate a plant, or where existing laws are lax, the union naturally can demand further evidence or examination, and to rectify this matter every engineers' organization, union or not, as well as trade organizations should demand more rigid license laws where they are not up to the recognized standard required in Massachusetts, Ohio and some other states.

It must be admitted, however, that there are isolated cases where some individual member has used his influence with the union to hold a position which he otherwise might not be able to hold, but these cases are rare and should be eliminated. On the other hand, the unions certainly have been instrumental in securing uniformity in the scale of wages for engineers in the same localities, doing the same class of work.

Columns could be written setting forth the advantages and disadvantages of unions, but having in mind the editorial in *Power* recently and the editor's reluctance to allow anything of this sort to "pass censor," I can only say that the motto of "Learn more, earn more" should be changed to read, "To earn more, learn more and take the necessary steps to see that you get it." To which end the engineers' union will be found of great assistance. J. C. HAWKINS.

Hyattsville, Md.

Inquiries of General Interest

Compensating Variation from Scale of Planimeter—How is a planimeter used for measuring the mean effective pressure shown by an indicator diagram made with a 16-lb. spring where the planimeter scale is intended to show m.e.p. for a 30-lb. spring? C. L. J.

Operate the planimeter as though a 30-lb. spring had been used and take 16/30 of the result.

Air-Space Walls for Boiler Settings—What is the advantage of air space, or cavity walls, for boiler settings? A. R. W.

An air space acts as a nonconductor for retarding loss of heat from radiation, and when cavity walls are properly designed and constructed, the spreading of the material adds to the strength and stability of the setting. If the outer walls are stayed to the inner walls by good forms of slip and expansion joints, the outer wall will be little affected by expansion and contraction from changes of temperature causing cracks for infiltration of excess air with detriment to furnace economy.

Angle of Advance with Negative Lap—When a D slide valve has negative steam lap, will the eccentric require positive or negative advance to close the steam port before the end of the stroke? T. J. M.

With negative lap the valve has the port uncovered during more than one-half a revolution of the shaft, and if the eccentric should be set at 90 deg. with the crank, the port would be uncovered both at the beginning and at the end of the stroke of the piston. Hence to have the port covered before the end of the stroke the eccentric must have positive advance, that is, must be set ahead of the 90-deg. position, which also would increase the lead or port opening at the beginning of the stroke and hasten all of the valve events

Single Shear and Double Shear—What is meant by a boiler rivet being in single shear or in double shear? F. A. P.

A rivet is said to be in single shear when it is subject to shearing action that tends to produce cleavage at a single cross-section of the rivet, as when used in a riveted lap-joint for holding together two plates that pull in opposite directions. A rivet is said to be in double shear when subject to shearing action that tends to produce cleavage at two cross-sections of its length, as when the rivet is used in a riveted butt-and-double-strap joint for holding together a main plate, sandwiched between an inside and outside cover plate whose direction of pull is opposite to that of the main plate.

Height of Pumping Water—A direct-acting steam pump with steam piston 12 in. diameter and water piston 8 in. diameter is operated with steam at 110 lb. per sq.in. gage pressure. To what height in feet can the pump raise water, assuming 70 per cent. efficiency? G. G. M.

If the total pressure exerted on the steam piston is transmitted to the water piston, 110 lb. per sq.in. gage pressure acting on the steam piston, opposed by back pressure of the atmosphere, would exert a pressure of $(12^2 \div 10^2) \times 110 = 158.4$ lb. per sq.in. on the water piston; one foot head of water exerts a pressure of 0.433 lb. per sq.in., and without friction of water in the pump or pipes the pump could raise the water to a height of $158.4 \div 0.433 = 365.8$ ft. above the level assumed by the suction water under atmospheric pressure. With 70 per cent. efficiency the height would be 0.70 of 365.8 = 256 feet.

Transmissive Capacity of Steel Shafting—What is the rule for estimating the approximate horsepower-transmitting capacity of the ordinary sizes of steel shafting? S. M.

The approximate number of horsepower capable of being transmitted with safety by ordinary sizes of turned steel lineshafting, when well supported, with pulleys near to the bearings and with the hangers so spaced that the deflection will not exceed 0.01 in. per foot of span, is equal to the cube of the diameter of the shaft in inches for 100 r.p.m. and directly in proportion for other speeds. The safe load for head shafts may be taken as 75 per cent. and for bare transmission shafts as 175 per cent. as much as for ordinary line shafting. Cold-rolled shafting may be taken as one-third stronger than turned steel shafting.

Guarantee Test of Oil Engine—How would a test be made of the guaranteed oil consumption of a 40-hp. oil engine running a 25-kw. 220-volt direct-current generator used for lighting? H. P. K.

To make the test conclusive the economy and regulation should be determined as nearly as possible for the different loads, speeds and other conditions specified in the guarantee. If constant loads of the given magnitude are not obtainable supplying power to the regular load circuit, the desired loads can be obtained by use of a temporary water-rheostat such as illustrated and described on pages 180 and 181 of Aug. 7, 1917, issue of *Power*. If the generator is not to be included in the guarantee, it will be necessary to take into account the efficiency of the generator at the different test loads. These data are generally obtainable of the manufacturer. For reliable results each test should run for a period of at least three hours, noting the weight, kind, source, and analysis of oil used; and readings should be taken at five-minute intervals of the speed of the engine and of the volts and amperes of electrical output. For any test period the average (volts $\times$ amperes) $\div$ 1000 will be the average kilowatt output, and the number of pounds of oil used per hour divided by the average kilowatts generated will be the oil consumption per kilowatt-hour.

Placing New Piston Rod in Engine—In putting in a new piston rod to replace an old one on a simple engine with V-shaped guides, what is the proper method of centering the rod? J. K.

In providing a new piston rod, the centering of the rod with the stuffing-box is likely to become misplaced. First of all, extend a line through the center of the cylinder past the guides and determine whether the faces of the guides are parallel with the cylinder center line, for that purpose measuring from the cylinder center line to a short round shaft or mandrel, placed in the V of the guide, and of suitable diameter to touch the sides of the V at about the middle of the wearing surfaces. If not parallel, the guides need to be made so by adjustment or as a repair or alteration of the engine. When the guides are parallel to the engine center line, place the new piston rod in the piston and with the piston in the crank end of the cylinder and the end of the rod parallel with the guides, adjust the packing rings so the rod will be in the center of the piston-rod stuffing-box. Then put the crosshead in place with necessary adjustment of the crosshead slippers to make the piston rod parallel with the guides when the rod is connected to the crosshead. If all adjustments have been properly made, the rod will travel centrally through the stuffing-box. If it does not, the vertical and horizontal adjustment of the crosshead should be made so there will be no movement of the stuffing-box gland when the engine is running, otherwise the rod will become scored and it will be difficult to make the packing hold tight.

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—Editor.]

Power Plants of Modern Ships

By ESKIL BERG

For the power plants of modern ships turbo-generators are built with an efficiency of over 80 per cent., which, with motors of 95 per cent. efficiency and boiler efficiency of 80 per cent., produce a shaft horsepower-hour with 0.825 lb. of coal of 14,000 B.t.u. Six new battleships for the Navy, requiring 33,000 hp. each and five large battle cruisers requiring 180,000 hp. each will be electrically driven. Steam consumption of 11.1 lb. per shaft horsepower-hour is guaranteed for the new battleship "New Mexico," which will be driven electrically.

IN a paper, "Propulsion of Ships," by Eskil Berg, engineer, General Electric Co., Schenectady, N. Y., before a joint meeting of the electrical section of the Franklin Institute and the Philadelphia Section, American Institute of Electrical Engineers, the following interesting figures were given relative to the power plants of modern ships; the abstract is from the March *Journal* of the Franklin Institute.

Speaking of the cautious advance in marine engineering, Mr. Berg said: Some of the Hudson River boats still have side wheels and use boilers with about 30-lb. steam pressure, producing a brake horsepower with about 30 or 40 lb. of steam. Steam engines were built as early as 1765, but it was not until 1807 that one was used to propel a boat. Electricity was used for power transmission as long ago as 1876, but its application as a medium for transmitting power to the propeller of a ship did not take place until 1908. This goes to show that progress in marine propulsion is very slow, the tendency being to follow the old and beaten paths.

The turbine is preferable to the reciprocating engine as a prime mover for ships, because it gives simple rotation and admits the possibility of a large range of expansion. At present the best steam engines are the triple and quadruple-expansion types; but on account of the size of the low-pressure cylinder an expansion ratio of more than 16 to 1 or 20 to 1 is not possible. In the turbine, however, there are practically unlimited possibilities of expansion, depending almost entirely upon the temperature of the condensing water. A vacuum of 29 in. is not at all unusual, and 29.5 in. is being recorded in some of the large central stations during the winter months. What this means may be better understood when we consider the available energy of a pound of steam when expanded from boiler pressure to various degrees of vacuum.

200-lb. pressure to 24 in. vacuum, 220,000 ft.-lb.
200-lb. pressure to 26 in. vacuum, 238,000 ft.-lb.
200-lb. pressure to 28 in. vacuum, 265,000 ft.-lb.
200-lb. pressure to 29 in. vacuum, 289,000 ft.-lb.

In other words, a turbine can realize about 25 per cent. more in the energy of steam than the reciprocating engine, which means a saving of about 25 per cent. in fuel, boilers, etc.

Turbines, when used for direct connection to the propeller shaft, must necessarily be designed to operate at a speed that is too low for the economical use of steam, and even then cannot be conveniently designed for a speed low enough to secure efficient propeller action. Sir Charles Parsons realized this and advocated the use of direct-connected turbines only for high-speed ocean liners requiring a large amount of power, and the "Mauretania" is probably one of the best examples of ships using this method of propulsion. The horsepower of the "Mauretania" is 68,000, the speed about 26 knots, and about 23.5 tons of coal per hour is required. The water rate obtained is about 11.5 or 12 lb. and the coal consumption about 1.5 lb. per shaft horsepower-hour.

Three years ago, when the White Star Line decided to build the "Olympic" and the "Titanic," which were slow-speed ships requiring about 25,000 hp., Mr. Parsons advocated a combination of two reciprocating engines exhausting into a low-pressure turbine, which gave an economy about comparable with the "Mauretania."

The steam engine is an efficient prime mover when operating at the higher temperature ranges; that is, an engine may have as high as 80 per cent. thermodynamic efficiency when operating from boiler pressure to atmosphere, whereas if it was operated down to a 28-in. vacuum, the efficiency would not be greater than 40 or 50 per cent. On the other hand, the turbine works efficiently in the low-pressure end of the cycle, so that by using a reciprocating engine in the upper ranges in combination with a turbine to utilize the turbine in the low-pressure ranges, an over-all efficiency is obtained which may be above that obtainable with either the reciprocating engine or the turbine when working alone. In the "Olympic" all reversing and maneuvering is done with the reciprocating engine, making it possible to build a simple and efficient low-pressure turbine.

With electric transmission, high steam pressure and superheat can be used, and the gain in fuel economy by its use has proved to be very appreciable. A steam temperature of 700 deg. F. is now successfully used in Europe, which, with 500-lb. steam pressure, would give 223 deg. F. superheat. The heat available for work would then be about 36.3 per cent., whereas under ordinary steam conditions with 200 lb. pressure and 50 deg. superheat, you would have only 30.75 per cent. available and a gain of 18 per cent. in fuel, which would more than compensate for any additional weight or cost of the electrical equipment.

Shaft Horsepower on 0.825 Lb. Coal

Turbo-generators are now built with an efficiency of over 80 per cent. which, with motors of 95 per cent. efficiency and a boiler efficiency of 80 per cent. would produce a shaft-horsepower-hour with 0.825 lb. of coal, containing 14,000 B.t.u. per lb. or 0.61 lb. of oil of 19,000 B.t.u. per lb., the latter figure comparing favorably with Diesel engines when lubricating oil is taken into consideration.

Owing to the wonderfully fine performance of the collier "Jupiter," which has now been in service for about four years, the Navy Department decided to install electric propelling machinery in the battleship "New Mexico," which is now nearly completed in the New York Navy Yard, and the apparatus for which has recently passed all Government tests at the Schenectady works of the General Electric Co. The Navy Department has also decided to install electric propelling machinery in six other new battleships, requiring about 33,000 hp. each and in five large battle cruisers requiring 180,000 hp. each.

The third instance of electric propulsion is the battleship "New Mexico." This installation provides conditions where the advantages of electric propulsion can be realized. The "New Mexico" is the largest and most powerful battleship that has been laid down by our Navy up to the present. She will have a displacement of 32,000 tons and a designed speed of 21 knots, requiring about 28,000 hp. The propelling machinery is, however, designed to deliver a maximum of 37,000 hp., and it is believed that this will give her a speed of 22 knots.

The equipment will consist of two turbo-generating units, four propelling motors (one for each shaft), switching apparatus, cables, instruments, etc. The contract also calls for two 300-kw. noncondensing direct-current turbo-generators, which will furnish excitation and power to drive the auxiliary machinery. As the General Electric Co. was required

to guarantee the steam consumption of the propelling machinery, including that of the auxiliary, the greatest care was taken in their selection, and they are all to be electrically driven. The exhaust steam from the direct-current generating sets, operating noncondensing, will be used for heating the feed water, and steam that may not be required for this purpose will be exhausted into the main turbine. The generators for the "New Mexico" are bipolar alternators, and the motors are arranged to be connected for either 24 or 36 poles. For economic cruising at a speed of 15 knots or less, only one generating unit will be required with the motors on the 36-pole connection. For higher speed the 24 polar motor connection will be used with both generators One generator, however, will be capable of driving the boat up to a speed of about 19 knots.

The steam-consumption guarantees as made to the Government cover the total amount of steam used by both the main generating units and the auxiliaries, and are as follows:

Steam pressure 250 lb. gage at the throttle
10 knots, 14.6 lb. per shaft. horsepower-hour
15 knots, 11.4 lb. per shaft horsepower-hour
19 knots, 11.1 lb. per shaft horsepower-hour
Maximum speed, 11.9 lb. per shaft-horsepower-hour

Very heavy penalties are attached to the guarantees in case they are not met; namely, $25,000 per lb. for the two lower speeds and $20,000 per lb. for the two higher speeds.

To be able to correctly judge the relative economy of different methods of propulsion, it may be interesting to compare the water rate per effective horsepower, taking for example such different methods as the battleships "Florida" and "Utah," which are equipped with Parsons turbines; the "Delaware," which has reciprocating engines; and the "New Mexico" with electric drive:

	Propeller Speed	Water Rate per Effective Horsepower per Hour 12 Knots	19 Knots	21 Knots
Florida	328	31.8	24.0	23.0
Utah	323	28.7	20.3	21.0
Delaware	122	22.0	18.7	21.0
New Mexico	175	17.3	15.0	16.4

That electric propulsion can be profitably applied to a small boat is proved by Mr. Ljungstrom, of Sweden, in the case of the small coastwise steamer "Mjolner," which is only 225 ft. long, 56 ft. beam and 15 ft. draft, requiring 900 hp. Two sister ships were built, namely, the "Miner" and the "Mjolner." The former was equipped with triple-expansion engines and Mr. Ljungstrom guaranteed a saving of 30 per. cent. in fuel in his method of electric propulsion in the "Mjolner" over the "Miner," equipped with engines. The boats have now been built and tested and the electrically driven boat showed a saving of 42.3 per cent in fuel consumption. This is indeed a remarkable record, but might be partly explained by the increase in efficiency of the boiler plant. For this electric drive Ljungstrom uses 218 lb. steam pressure and 235 deg. superheat, and this alone would effect a saving in coal over the "Miner" of about 15 per cent.

Emergency War Training

Emergency War Training for Gas-Engine, Motor-Car and Motor-Cycle Repairmen, is the title of Bulletin No. 10, recently issued by the Federal Board for Vocational Education, Washington, D. C. This bulletin contains 78 pages and gives an outline and suggestions for courses designed to train men to repair motor-trucks, motor-cars, motorcycles and airplane motors. As pointed out in the foreword:

There is a critical and constantly growing need for many thousands of mechanics and technicians for army occupations carried on in and behind the lines of the United States Army. Many of these workers, already experienced in similar occupations of civil life, will be secured through the draft, and possibly through voluntary enlistment. It is recognized by those in a position to know, that the quota thus gained will not be sufficient and that it will be necessary to train many thousands of men in various ways for various occupations. The War Department has taken definite steps to provide for this training systematically through army schools, in some instances at cantonments, but largely at the industrial, trade and engineering schools of the country.

For some months the Federal Board has been making intensive investigations and studies of the demands of these army occupations. A series of bulletins for the guidance of those giving this training has resulted from these studies. The courses and methods suggested in these bulletins have been carefully checked by experienced army officers and represent the consensus of opinion as to what training should be given and how it should be given.

Bulletins thus far published are: No. 1, Statement of Policies; No. 2, Training Conscripted and Enlisted Men for Service as Radio and Buzzer Operators in the United States Army (International Code); No. 3, Emergency Training in Shipbuilding—Evening and Part-Time Classes for Shipyard Workers; No. 4, Mechanical and Technical Training for Conscripted and Enlisted Men (Air Division, United States Signal Corps); No. 5, Vocational Rehabilitation of Disabled Soldiers and Sailors (also printed as S. Doc. No. 166); No. 6, Training of Teachers for Occupational Therapy for the Rehabilitation of Disabled Soldiers and Sailors (also printed as S. Doc. No. 167); No. 7, Emergency War Training for Motor-Truck Drivers and Chauffeurs; No. 8, Emergency War Training for Machine-Shop Occupations, Blacksmithing, Sheet-Metal Working and Pipe Fitting; No. 9, Emergency War Training for Electricians, Telephone Repairmen, Linemen and Cable Splicers; No. 10, Emergency War Training for Gas-Engine, Motor-Car and Motor-Cycle Repairmen; No. 11, Emergency War Training for Oxyacetylene Welders; No. 12, Emergency War Training for Airplane Mechanics—Engine Repairmen, Woodworkers, Riggers and Sheet-Metal Workers; No. 13 (Agr. Ser., No. 1) Agricultural Education—Organization and Administration.

Persons desiring to secure copies of any or all of these bulletins can readily do so by applying to the Federal Board for Vocational Education, Ouray Building, 805 G Street, N. W., Washington, D. C.

Consolidation of Power Companies Proposed

There is on foot a proposition to consolidate the hydroelectric power companies at Niagara Falls. This is at the request of and in coöperation with the War Department as a necessary war measure to provide sufficient electrical energy for war industries in and about the City of Buffalo.

The companies to be consolidated are the Niagara Falls Power Co., the Hydraulic Power Co. and the Cliff Electric Distributing Co. If carried out, this consolidation will call for an expenditure of about $15,000,000 for the construction of an additional plant and equipment, whereby it is hoped to increase the output by 170,000 hp. above the amount now being generated by the independent operation of these companies.

Engineers are also occupied with the proposed power coördination plans of Dr. Garfield, and they, representing the utility interests throughout the United States, are working out rates for transmission line for tying in and estimating of costs.

Fuel and water-power experts are considering linking up the Lehigh Coal and Navigation plants at Lansford and Hauto with the Philadelphia Electric Co. in supplying power to Hog Island, League Island, Eddystone, Westinghouse, Bethlehem, Midvale and all other large industrial establishments.

Moreover, there is a possibility that three or more power plants of 100,000 hp. will be erected at other points in the anthracite region to supply energy to other industrial establishments throughout Pennsylvania so as to link up a chain of such units which would afford a better supply for munition work.

It is also understood that plans are contemplated for linking up power-generating plants from New England to the District of Columbia in units that will be able to supply transmission facilities with a view to affording relief when difficulties may incapacitate the service at any section. This would prevent the crippling of power and lighting circuits which might occur due to one cause or another.

Modifications of Coal Prices

Owing to a reclassification of the coal fields in several districts in West Virginia, in part of Kentucky, and in the coal-mining districts of Missouri, Kansas and Virginia, the selling prices of some coals are slightly changed. The new prices, which are now effective, are as follows:

State	Run-of-Mine	Prepared Sizes	Slack or Screenings
West Virginia:			
No. 10 district: Coal and coke and Gauley districts; Taylor, Barbour, Lewis, Buckhannon, Randolph, Gilmer, Braxton, Webster, and Greenbrier Counties; operations in Nicholas County east of the mouth of the Meadow Branch of the Gauley River and coal and coke district in Kanawha and Clay Counties north of Charleston	$2.30	$2.55	$2.05
Fairmont district: Monongalia, Marion and Harrison Counties	2.15	2.40	1.90
Thacker district: Operations in McDowell County west of Panther on the Norfolk & Western and in Wingo County west along the Tug Fork of the Big Sandy River to Williamson on the Norfolk & Western	2.30	2.55	2.05
New River district: Fayette County south of Hawk's Nest on the Chesapeake & Ohio and Fayette and Raleigh Counties south of Paintsville on the Virginian Railroad and Wyoming County north of Herndon on the Virginian Railroad	2.35	2.60	2.10
Logan district: Logan County and operations in Boone County south of Danville on the Chesapeake & Ohio and Lincoln County south of Gill on the Chesapeake & Ohio	2.15	2.40	1.90
Putnam County	2.50	2.75	2.25
Kenova district: Operations on the watershed of the Tug Fork of the Big Sandy River west of Williamson on the Norfolk & Western, and Wayne County	2.30	2.55	2.05
Kanawha district: Nicholas County west of the mouth of the Meadow Branch of the Gauley River, Fayette County west of Hawk's Nest on the Chesapeake & Ohio, and north of Paintsville on the Virginian Railroad, and operations in Raleigh and Boone Counties on the watershed of the Clear Fork Branch of Coal River, Boone County, north of Danville on the Chesapeake & Ohio, Kanawha County south of Charleston, and Lincoln County north of Gill on the Chesapeake & Ohio	2.25	2.50	2.00
Kentucky:			
Thacker district: Operations in Pike County on the watershed of the Tug Fork of the Big Sandy River east of Williamson on the Norfolk & Western Railroad	2.30	2.55	2.05
Kenova district: Operations in Pike County and Martin County on the watershed of the Tug Fork of the Big Sandy River west of Williamson on the Norfolk & Western Railroad	2.30	2.55	2.05
Missouri:			
District No. 1: Audrain, Bates, Calloway, Henry, Johnson, Monroe, Randolph, Ralls, St. Clair, Schuyler, Vernon and Montgomery Counties, Adair County, except operations of the Star Coal Co., and Macon County, east of New Cambria and mining operations not covered by other rulings	2.70	2.95	2.45
District No. 2: Boone, Clay, Cooper, Chariton, Carroll, Dade, Harrison, Linn, Lafayette, Putnam, Ray, and Sullivan Counties and Macon County west of New Cambria and the long-wall thin-seam mines in Randolph County	3.15	3.40	2.45
Grundy County: Operations of the Star Coal Co., in Adair County and shaft workings in the Lightning Creek or upper thin vein in Barton, Bates, and Vernon Counties	3.65	3.95	2.45
Platte County	3.40	3.65	2.45
Kansas:			
Cherokee and Crawford Counties, except shaft mines in Lightning Creek or upper thin vein and any mining operations in the State not covered by other rulings	2.70	2.95	2.45
Shaft workings in the Lightning Creek or upper thin vein, in Cherokee and Crawford Counties	3.65	3.95	2.45
Osage, Franklin and Linn Counties	3.50	4.50	2.80
Leavenworth County	3.40	3.65	2.90
Virginia:			
Mines operated near St. Charles, Lee County, by the Darby Coal Mining Co.; Black Mountain Mining Co.; Virginia Lee Co.; Old Virginia Coal Co.; United Collieries Co.; Benedict Coal Corporation; and the Imperial Mine of the Virginia Iron, Coal and Coke Co., Roanoke, Va	2.65	2.90	2.40

These prices do not include the allowance to operators of 45c. a ton who have complied with the wage increase agreement.

The Fuel Administration has also issued a ruling on the prices of coal from wagon mines, which are mines that are not located on railway lines, so that the coal must be transported from the mine mouth to the railroad in wagons.

Operators of wagon mines will not be allowed to add the cost of hauling to the Government price when the coal is loaded into open-top cars, except when such coal is bought by a railroad for its own use.

This decision of the United States Fuel Administration affirms the rulings promulgated by it Oct. 6, 1917, under which operators of wagon mines are permitted to make a charge of not more than 75c. in addition to the Government price when delivering direct to the consumer or when loading into box cars.

Representatives of the wagon-mine operators sought to induce the Fuel Administration to make a similar allowance for loading into open-top cars. They based their request upon the claim that congestion of the railroads has been relieved sufficiently to justify the use of open-top cars by wagon mines, and that the cost of hauling was the same whether the coal was loaded into box cars or open-top cars.

Investigation of the situation, however, has satisfied officials of the Fuel Administration that the demand for open-top cars by mines that can load only into that kind of cars still exceeds the supply. Under the circumstances, therefore, it was decided that production would be stimulated best by restricting the allowance for hauling to those wagon mines loading into box cars.

Ammonia Oil Separator Explodes

About 10 o'clock Saturday morning, Apr. 27, a high-pressure ammonia oil separator in the Chicago Cold Storage Co.'s plant at Sixteenth and South State Sts. exploded, injuring ten men. The separator was located between the compressor and the condenser on the roof, on a railroad loading platform adjoining the building. The men working in its vicinity at the time of the explosion were injured, most of them being overcome by the escaping ammonia fumes. It is believed that none of the injuries will prove fatal.

In the plant there are three 175-ton vertical compressors, each with two single-acting cylinders. Each compressor is protected by a safety valve set to blow at 250-lb. gage pressure. Depending upon the load and other operating conditions, the condenser pressure varied from 145 to 180 lb. At the time of the explosion the plant log showed it to be 175 lb. gage, and the suction pressure 2 lb. gage. The suction line to the compressor was 5 in. diameter, which is small for pressures as low as 2 lb. gage. It is quite probable that the vapor came back to the machine superheated, and, in being compressed to 175 lb., the temperature would be abnormally high.

The separator was cast of ferro-iron to a diameter of 16 in. and a length of 42 in. The bottom was convex, while the top head was flanged and fastened to the body by sixteen 1⅛-in. bolts. While no blowholes or flaws in the casting could be detected, it was noticed that the cylinder walls were of uneven construction, the thinnest part of the metal being an inch thick. Assuming 30,000-lb. tensile strength for the ferro-iron, the 16-in. cylinder would carry a safe working pressure of 375 lb. per sq.in., based on a factor of safety of ten instead of the eight generally assumed. It is evident that the separator was fully protected by the safety valve and that temperature rather than pressure was the initial cause of the accident.

Thomas Andresen, cooling-plant inspector for the city, investigated the explosion and advances the following theory as to the cause of the accident: The machines were operated with a low suction and a high condenser pressure. Through a leaky stuffing-box sufficient air may have found its way into the cylinder and, in combining with the evaporated hydrocarbon gas from the lubricating oil, formed a dangerous and explosive mixture which was ignited by the unusually high temperature induced by the superheated state of the incoming vapor and the high condenser pressure. No machine or system was ever built to withstand the instantaneous pressure of a hydrocarbon explosion, and as a matter of course the weakest part gave way first. In this case it was the oil separator.

In an explosion of this kind safety valves are of no avail. The cause of the accident must be laid to the unfortunate conditions that build up while the compressor is apparently operating under normal conditions. Similar explosions have occurred frequently when systems that have been in operation are being tested under air pressure. To avoid these pos-

sible air explosions, as they are termed, the new rules issued by the City of Chicago prescribe that when testing any existing plant with air, the pressure must not exceed 100 pounds.

Courses for Training Mechanics and Technicians for the Army

Last February the Secretary of War appointed the Committee on Education and Special Training, charging it with the responsibility of training 90,000 men of the National Army for various technical and skilled work. The army is in need, for example, of motor-truck drivers, airplane mechanics, carpenters and blacksmiths. The selective draft methods proving inadequate to supply this demand, the committee was formed to arrange for intensive training.

Educational plants equipped for handling large numbers of students were obviously the machinery that should be adapted to this work. So rapidly has the committee proceeded that 25 schools are now under contract to take the men, 14 schools have begun their work and 7500 National Army men are under instruction. The number of schools will be increased until 30,000 men can be handled at one time. The courses are of eight weeks' duration and the final lot of 30,000 men (for army needs as planned at the minute) will go to the schools Sept. 1.

In arranging for the work institutions were preferred that could accommodate at least 500 men. The institutions include engineering colleges, universities, and mechanics' institutes, while in one city the public-school system is being used. The number of different courses given at an institution depends on various conditions—the number of students, the character of school equipment, location, etc. One school, the University of Virginia, will specialize on the training of motor-truck drivers and will take 600 men at a time. For the truck-driving courses such automobile equipment will be used as is available, and the Government, in addition, will furnish one army truck for each 20 men.

Army officers will be located at each school, and military drill will be carried along simultaneously with the technical instruction. The technical staff will be supplied by the institutions and, with the army officers, will form a board to direct the administration.

The Curricula used are those outlined for intensive training by the Federal Board for Vocational Education, though the staff at each school is given much latitude in the presentation of the essential matter. At some schools coöperation with the local industries is being arranged, as, for example, in the instruction on rubber vulcanizing at Akron, Ohio. At present the following courses are arranged for: Auto driving and repair, bench woodwork, general carpentry, electrical communication (telephone and telegraph work), electrical work, forging and blacksmithing, gas engines, machine shop, sheet metal.

While the men at the schools are National Army men and come through the draft boards, they volunteer for this special training. The Provost-Marshal-General sends out a call to the boards for men with experience fitting them for the lines in which the training is to be given, and are asked to certify volunteers from their rolls. In other words, the men go to the schools directly from their homes and are not drawn from the cantonments. As a result of this volunteer system a very good grade of men has been secured.

The men are required, in addition to their experience, to have had a common school education—though this is not a hard-and-fast rule. Aptitude and ability to learn are the chief requirements.

In the courses themselves the aim will be to push men along as fast as their abilities warrant. Journeymen machinists, for example, will immediately be put on highly specialized work, such as airplane repairs.

All men are ranked as enlisted privates and are paid accordingly, and, of course, are outfitted by the Government. The schools, as a rule, contract for the housing, feeding and instruction in a lump sum per man, per day, but in some cases the housing and feeding will be done by other parties. In arranging for accommodations the Quartermaster's Department has been of invaluable assistance, furnishing cots and other equipment to institutions having the buildings, but lacking the necessary dormitories and dining-room equipment. All sorts of expedients have been used in places where building space was lacking except for the actual instruction. Armories have been converted, and in several cases fair grounds have been used.

To facilitate the work the country has been divided into ten districts, the institutions in each coming, as to the technical instruction, under the direct supervision of a district director. These in turn are under the direction of the general educational director, C. R. Dooley, formerly of Pittsburgh. The committee itself consists of three army officers, Lieut.-Col. J. H. Wigmore, Lieut.-Col. R. I. Rees and Major Grenville Clark. Assisting them is an advisory board consisting of Hugh Frayne, representing labor, and the following representatives of educational interests; J. R. Angell, the colleges; S. P. Capen, Federal bureau of education; J. W. Dietz, corporation schools; C. R. Mann, schools of pure science; Dean Herman Schneider, engineering schools.

Chicago Engineers Hold Joint Meeting

On Apr. 23, C. F. Kettering, president of the Society of Automotive Engineers, gave a most interesting address on "The Automobile Power Plant." The occasion was the first joint meeting of the Chicago Section of the American Society of Mechanical Engineers with the American Institute of Electrical Engineers and the Western Society of Engineers, and the place was the rooms, in the Monadnock Block, of the society last named. The attendance approximated 250. The interest in the subject and the great success of the meeting generally mean that there will be more of them and that active sectional coöperation is in sight.

A. D. Bailey, president of the Chicago Section of the American Society of Mechanical Engineers, presided. In his talk, Mr. Kettering explained very simply the construction and working of the internal-combustion engine, his remarks applying primarily to the four-cycle type. He discussed carburetion, gas feeding, ignition, and gave an elementary conception of fuels and their action in burning. Best of all, he refuted the pessimistic press reports of the airplane situation and reacclaimed the Liberty motor as a wonderful engine, maintaining that in lightness, economy and simplicity it has no superior in Europe. An important outstanding feature was a single design for many services as compared to at least thirty different makes in France or in England. The advantage in supplying repair parts is self-evident. Dimensions of cylinders and parts are standard throughout. To increase the power is merely a question of adding more cylinders. The speaker gave a clear idea of the conditions in service, distinguished between the different types of airplane, and at the end was flooded with a variety of questions pertinent to the subject under discussion.

Ninth Annual Dinner of the Boston Engineers

The Engineers of Boston held their ninth annual dinner at the Boston Club on the evening of Apr. 30 under the auspices of the Boston Society of Civil Engineers, the American Society of Mechanical Engineers and the American Institute of Electrical Engineers. Mayor A. J. Peters was present and made a short address. William H. Blood, Jr., of the American International Shipbuilding Corp., gave a description, illustrated by lantern slides and moving pictures, of the Hog Island shipyards. Arthur D. Flinn, secretary of Engineering Council, told of the organization of the council, its purposes and processes. Maj.-Gen. E. F. Hodges spoke briefly, and A. M. Westendorf showed films of a 22-ft. motor boat which could be maneuvered, reversed and steered both backward and forward by a simple manipulation of the rudder, without altering the direction or speed of the engine. Prof. Charles M. Spofford was chairman of the committee, and James W. Rollins toastmaster.

Interior Surface Defects as Cause of Condenser-Tube Corrosion*

By W. Reuben Webster

It is the belief of some engineers that defects on the interior surfaces of brass condenser tubes act to accelerate corrosion and that accordingly their presence even to a small degree should not be tolerated. Extended observation has failed to furnish a basis for such a belief. Many observations have developed the fact that the variety of corrosion that exhibits itself in local pitting resulting in perforation takes place independently of any interior defects that may exist. No tendency of the pitting to localize on or penetrate the tube at a surface defect has been observed.

It is a common experience to find clauses in specifications that have been adopted by the writer thereof because the requirements which they demand appear to be reasonable but which have, as a matter of fact, no basis either in theory or experience.

Certain users of brass condenser tubes have been impressed with the belief that interior surface defects operate to produce corrosion which exhibits itself in the formation of local pitting, terminating in perforation. The writer at one time held this belief and took occasion to make a careful examination of every case of corrosion of this character which came under his notice, with a view to observing whether there was any evidence in support of it. No case, however, has ever been found by him which would support any such view. It has not been found possible to show that tubes that contained such interior surface defects were any more subject to corrosion than those that were free from them.

It has further been observed that there is no tendency whatever for areas of corrosion to localize in the vicinity of such defects. Moreover, many cases have been found in which severe pitting had occurred in the vicinity of such defects, but no tendency of the corroded areas to follow along the lines of defect has been noticed.

A recent case of severe corrosion was observed which furnishes strong evidence that no such connection exists. The tubes had been in service in the condenser of a large stationary plant for a period of six months, and were removed because of perforations caused by local corrosion on their interior surfaces. Of a lot of eleven tubes, eight were found to be free from surface defects in the vicinity of the corroded areas, while three samples were found to contain such defects. These tubes were sawed longitudinally and opened out flat so as to show the interior surfaces. Three characteristic samples from the unblemished tubes were photographed for comparison with three containing surface defects.

Particular attention is called to the fact that even where a corroded area crosses a defect, no tendency whatever for corrosion to follow the defect is observable. In most of the samples the corroded area was confined to a distance not over four inches from the inlet end of the tube; the remainder of the tube being as free therefrom as when first made. In one or two cases the corroded area was similarly confined to a short distance in the length of the tube, but was some distance from its end.

The effect that temperature has upon corrosion was well shown by the fact that the corroded area in most cases stops quite abruptly on reaching that portion of the tube in contact with the tube sheet. There would be a considerable difference in temperature between the portion of the tube in contact with the tube sheet and that in contact with the steam.

It is not intended that the evidence herewith presented should be considered as arguing in favor of the presence of defects of this character. It is, however, a fact that evidence of their existence can be largely removed by treatment that detracts from the resistance of the tube to corrosion, while on the other hand they are rendered more highly visible by treatment that tends materially to increase this resistance.

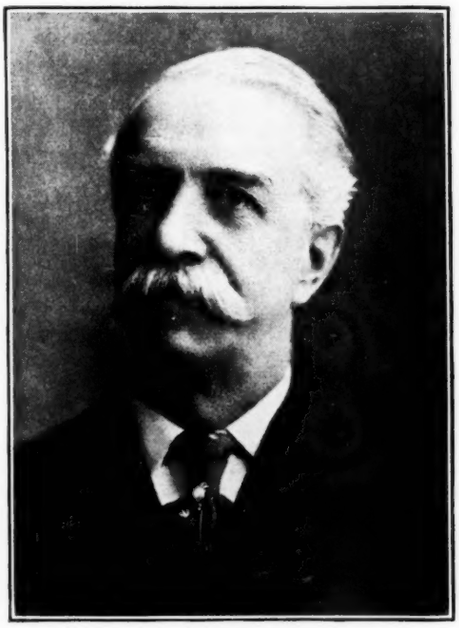
As a consequence, tubes treated in a manner tending to decrease their serviceability will frequently be accepted under specifications containing restrictions of the character in question, but would be rejected when made in accordance with methods calculated to give them the maximum endurance.

It, therefore, follows that a rigidly interpreted clause of this nature may operate to weaken rather than strengthen the specifications of which it is a part.

*From a paper before the American Society for Testing Materials.

Charles Jenkins

Charles Jenkins died May 1, 1918, at his summer home at Winthrop Heights, Mass. He was born in Boston in 1852, the son of Nathaniel Jenkins, the inventor of the well-known Jenkins valve. After the death of their father in 1872, the brothers, Alfred and Charles, formed a partnership under the name Jenkins Brothers, to continue the business of their father. Charles remained a member of the firm until 1896, when he sold his interest to his brother and retired to devote his time to his real-estate interests in Boston, residing at 847 Beacon Street.



CHARLES JENKINS

Submarine Engineer Officers Wanted

The Navy is in need of professional engineers for submarine duty, not over 35 years old and physically strong. The qualifications include citizenship in the United States, the degree of mechanical, electrical or mining engineer from a university of recognized technical standing and at least two and one-half years' practical engineering experience. The candidates selected will be commissioned Ensign in the U. S. Naval Reserve Force, and will be sent to the Naval Academy and to the Submarine School in New London for a special technical course.

Engineers subject to the Selective Draft Law and those now in the Army are eligible. Letters from at least three responsible personal acquaintances must accompany each application. Address the American Engineering Service of the Engineering Council, Room 903, 29 West 39th St., New York City. Early responses are requested.

A book will tell you how to open or close a throttle, but that operation is not all there is to starting and stopping an engine. You can get information from books, but never skill.—*Marine Engineering.*

Personals

C. A. Binz, formerly manager of the meter department of Yarnall-Waring Co., is now sales manager of the company.

Albert Tate Smith has returned to The Permutit Co., with which he was formerly connected, to take the position of assistant manager of sales.

Thomas C. Green, of the Garlock Packing Co., Pittsburgh branch, has recently been appointed secretary of the National Exhibitors' Association connected with the N. A. S. E. in place of J. William Peterson, of the Richardson-Phenix Co., resigned.

Laura G. Edwards, who was connected with the advertising department of the National Tube Co. in Pittsburgh and Kewanee for over 12 years, resigned to enter upon a broader opportunity in the publicity department of the A. M. Byers Co. on Apr. 1.

F. W. Fischer has resigned as chief engineer of the Standard Knitting Co., of Knoxville, Tenn., to accept a position with the Air Nitrates Corporation. After a few weeks spent in studying the processes at Niagara and elsewhere, he will assist in the installation of the U. S. Nitrate Plant No. 2 at Muscle Shoals, Ala.

Prof. F. H. Newell, head of the Department of Civil Engineering at the University of Illinois and organizer and director of the United States Reclamation Service, has been awarded the Cullom Geographical Medal by the Geographical Society of New York. Professor Newell is a prominent member of the American Society of Mechanical Engineers and of the American Association of Engineers.

Engineering Affairs

Perth Amboy No. 13, N. A. S. E., will hold its 27th annual state convention, June 1-2. Exhibits will open on May 31.

The Southeastern Section of the National Electric Light Association will hold its annual meeting at Atlanta, Ga., June 19-20.

The American Institute of Chemical Engineers will hold its summer meeting at Berlin, N. H., June 19-22, with headquarters at Mt. Madison House, Gorham.

The New Haven Section of the A. S. M. E. will hold a meeting on May 10. There will be papers and informal talks by engineers of local companies on "Munitions Manufacture."

The Power Section of the Providence Engineering Society will hold a meeting on the evening of May 8, 1918, at which L. B. McMillan, of New York, will give a talk on "Thermal Insulation."

The New Orleans (La.) Section of the A. S. M. E. will hold a joint meeting with the Louisiana Engineering Society on May 13. Dr. Winship will present a paper on "Power Plants of the Oil Tankers Being Built at New Orleans."

The American Order of Steam Engineers will hold its 32nd annual convention at the Parkway Building, Broad and Cherry Sts., Philadelphia, June 10-12. Owing to general existing conditions, there will be no exhibit held in connection with the convention this year.

The National Electric Light Association will hold its regular annual meeting this year in Atlantic City, N. J., with the Hotel Traymore as headquarters, June 13 and 14. The sessions will be devoted entirely to a consideration of vital war problems as related to the industry. In view of the fact that practically all member companies are short-handed and their officers have their time taken up not only with general problems of the industry, but also with local problems and difficulties that come upon them as patriotic citizens, it is believed that the attendance will inevitably be much smaller and more restricted than would occur in normal times and under the usual conditions, all other subjects, however important, being swallowed up for the time being in the fundamentally vital and essential one of winning the war.

The National Gas Engine Association will hold its eleventh annual meeting at the Sherman Hotel, Chicago, June 3-4. The subjects to be discussed on Monday are as follows: "The Iron and Steel Situation"; "Government Requirements on Gas Engines and the Method of Handling Those Matters at Washington"; "The Labor Situation"; "The Fuel Problem," which will be handled by a representative of the Federal Fuel Administration. On Tuesday forenoon the following paper will be read: "What Is the Future of the Farm Gas-Engine Business"; "Sizes of Manufacture from the Manufacturing and Sales Standpoint"; "The Present Condition and Future of the Gas-Engine Export Trade." On Tuesday afternoon there will be a technical session in connection with the Mid-West Section of the Society of Automotive Engineers, at which several papers of a technical nature will be presented and discussed.

The American Institute of Electrical Engineers will hold its 34th annual convention at the Marlborough-Blenheim Hotel, Atlantic City, N. J., June 26-28, 1918. Six technical sessions are contemplated. The convention will open at 10:30 a. m. on Wednesday June 26, with President E. W. Rice, Jr.'s, address. This will be followed by the technical committee reports. The following papers will be presented Wednesday, 2:30 p. m.: "Split-Conductor Cables—Balanced Protection," by William H. Cole; "Overhead Transmission Cables," by E. B. Meyer; "The Application of Theory and Practice to the Design of Transmission Line Insulators," by G. I. Gilchrist. Thursday, 10:30 a. m.: "Lightning-Arrester Spark Gaps," by C. T. Allcutt; "The Oxide-Film Lightning Arrester," by C. P. Steinmetz; "Design of Transpositions for Parallel Telephone and Power Circuits," by H. S. Osborne. Thursday, 2:30 p. m.: Members and section delegates conference. Thursday, 8.30 p. m.: "Fixation of Nitrogen," by E. Kilburn Scott; "America's Power Supply," by C. P. Steinmetz. Friday, 10:30 a. m.: "Precharged Condensers," by V. Karapetoff; "Method of Symmetrical Coördinates Applied for the Solution of Polyphase Networks," by C. L. Fortescue: "Flux Distribution in Alternators Under Sustained Short-Circuit Conditions and Different Loads," by N. S. Diamant. Friday, 2:30 p. m.: "Protection from Flashing in D. C. Apparatus," by J. J. Linebaugh and J. L. Burnham; "The Automatic Hydro-Electric Plant," by J. M. Drabelle and L. B. Barnett.

Miscellaneous News

The New Transmission Line from Windsor, Vt., to Claremont, N. H., has been completed and is now in operation. Some economics in operation and better service should be effected through this new line.

Excavation Work for the new 10,000-kw. turbine to be installed at the Dock Street plant, Easton, Penn., has been started. Provided no unusual difficulties are met with, this turbine should be in operation by Aug. 1, next.

A Boiler Exploded at a grist mill on White Oak Creek, in Estill Co., Ky., on Apr. 5, instantly killing two men and injuring half a dozen, one of whom died later from injuries and another lay at the point of death at the time this report was received. The mill was blown some distance from its foundation, and every one in it was more or less seriously injured.

The Eighth Edison Medal has been awarded by the Edison Medal Committee of the American Institute of Electrical Engineers to Col. John Joseph Carty for his work in the science and art of telephone engineering. The medal will be presented to Colonel Carty at the annual meeting of the Institute to be held in the Auditorium of the Engineering Societies Building, Friday, May 17, 1918, at 8:30 p. m. President E. W. Rice, Jr., will preside and the program will be: Address by A. E. Kennelly, outlining the origin and purpose of the Edison Medal; address by Michael I. Pupin, giving history of Colonel Carty's work in regard to telephone engineering; presentation of medal by President Rice; acceptance of the medal by Colonel Carty.

The Output of Bituminous Coal increased 366,000 net tons, or 3.4 per cent. during the week ended Apr. 27, compared with the week previous. We are not, however, getting out the large production that we should, in order to provide for the excessive demand of the coming winter. A part of the falling off is due to lack of cars, many of which have been diverted to meet the demand of the army on account of the drive on the West front. Some of the mines which could get cars are actually idle for lack of orders. It is not known to what extent cars are being added to the railroad equipment. The way that the consumer can help most is to get in orders for all that he is going to need next winter as early as possible, and to take and store all that he can, but not, of course, in excess of his probable requirements.

NEW CONSTRUCTION

Proposed Work

Mass., Newburyport—The Newburyport Gas and Electric Co., 49 Pleasant St., plans to build an addition to its new electric plant on the former Fiberloid wharf. C. Spaulding, Supt.

Mass., Westfield—City plans to appropriate $42,000 to purchase equipment for its light department to enable it to utilize power from the Turners Falls plant.

N. Y., Geddes—The Syracuse Lighting Co., plan to build a brick electric plant. B. H. Shepard, 514 City Bank Bldg., Syracuse, Pres.

N. Y., Groton—The Groton Electric Co., is having plans prepared for the erection of an electric power plant. F. J. McGee, 622 East 113th St., New York City, Pres. Noted Oct. 7.

N. Y., Marshall—The Waterville Gas and Electric Co. plan to build an electric plant B. H. Shepard, 514 City Bank Bldg., Syracuse, Pres.

N. Y., Mohawk—State is having plans prepared by F. M. Williams, Engr., Capitol, Albany, for the erection of a hydraulic power plant on the State Barge Canal here.

N. Y., New York—The Bellevue and Allied Hospitals plan to build a new power plant at the foot of East 26th St.

N. J., Camden—Kind & Lantesmann, 5th St., has had plans prepared for the erection of a new boiler plant.

N. J., Jersey City—Swift & Co., 154 9th St., plan to build a 2-story addition to its engine and power plant on Henderson St. Estimated cost, $23,700.

N. J., Newark—A. Fink and Son, 810 Frelinghousen Ave., has had plans prepared for the erection of an addition to its engine house in connection with its factory.

N. J., Pompton Lakes—City has voted $46,900 bonds for the erection of an electric power plant on Corning Lake.

N. Y., Brooklyn—The State Hospital Commission, Albany, will receive bids until May 22, for installing underground connections and building an addition to its boiler house. E. S. Elwood, Secy.

Penn., Germantown—City plans to build an electric lighting plant on Duval and McCallum St.

Penn., McKeesport—The Atlantic Refining Co., 6th Ave., Pittsburgh, plan to build a service station on Walnut St. and 8th Ave. Estimated cost, $15,000.

Penn., Steelton—The Bethlehem Steel Co. plan to install four 250 hp. boilers each, in its new addition now under construction.

Va., Richmond—Hackley Morrison, Moore Bldg., 16 North 9th St., is in the market for a 75 kw., 125 volt, direct current generator directly connected to a generator.

Ga., Commerce—City voted to issue $15,000 for the erection of electric lighting plant. C. A. Goodin, Clerk and Treas. Noted Apr. 16.

Ga., Jefferson—City issued $15,000 bonds for an electric lighting plant and water works system. Noted Feb. 19.

Fla., Oldsmar—The Oldsmar Electric and Ice Co., recently incorporated, plan to install an electric lighting plant and ice factory. J. Bornstein, Pres.

S. C., Branchville—P. Ott is in the market for equipment for an electric lighting plant.

Miss., Purvis—City retained X. A. Kramer, Engr., Magnolia, to prepare plans for the installation of an electric lighting system here.

La., Monroe—The Standard Gin Co., recently organized with $60,000 capital stock, is in the market for power plant, and cotton gin equipment. J. P. Parker, S. Schienker and J. T. Austin, incorporators.

La., Powhattan—The Yarborough Co. plans to purchase Scotch boilers and other power plant equipment.

Ohio, Columbus—The Columbus Anvil and Gorging Co. plan to build a new power plant in connection with its factory on West Frankfort St. T. N. Long, Mgr.

Ohio, Lowellville—The Sharon Steel Hoop Co. is in the market for a 15-ton electric crane for its finishing mills here.

Ohio, Mansfield—The City School District will receive bids until May 15, for the construction of a heating and ventilating system in the Brinkerhoof School on Marion Ave. J. H. Bristor, Clerk.

Ohio, St. Paris—City voted $5500 bonds for improvements to its electric lighting plant.

Ind., Indianapolis—The Ross Power Equipment Co., Merchants Bank Bldg., is in the market for a 250 kv.-a., 240/440 volt, 60 cycle, 3 phase engine type generating unit for 125-150 lb. steam, 3-5 lb. back pressure, one 400 kv.-a. generating unit, same as above, one 150 kw., 250 volt compound generating unit directly connected and one 250 and one 500 kw., either simple or tandem, compound engines.

Ill., Pecatonica—City plans to install an electrically operated pump at its pumping station after July 1.

Wis., Eau Claire—The Standard Oil Co. of Indiana, plans to build a complete service and distributing group here. Estimated cost, $30,000. W. W. Holcomb, La Crosse, Dist. Mgr. R. M. Adams, 72 West Adams St., Chicago, Archt.

Wis., Mehesha—City is considering the installation of an additional engine in its electric lighting and water works plant.

Wis., Winneconne—The Winnebago Electric Co., recently incorporated, plans to establish an electric lighting plant here. R. W. Button, interested.

Iowa, Eldora—Hardin Co. receives bids about June 11 for brick boiler house, smoke stack, etc. About $15,000. C. Boylan, Co. Aud

Iowa, Red Oak—The Red Oak Electric Co. has applied to the Board of County Supervisors for a franchise to build and operate an electric transmission line on certain roads in Pleasant Township.

Minn., Virginia—City plans to build heating plant.

Kan., Brookville—City voted to issue bonds for the erection of an electric distribution system.

Neb., Lynch—City voted $7800 bonds for the installation of an electric lighting plant.

Ark., Little Rock—The Board of Education will soon award the contract for the installation of a heating and lighting system in the grade and junior high school. L. Thompson and T. Harding, 504 Southern Trust Bldg., Archs.

Tex., Beaumont—The Kansas City Southern R. R. Co., Kansas City, Mo., plans to install electrical equipment to operate the drawbridge over the Neches River here. J. M. Wier, Kansas City, Mo., Ch. Engr.

Okla., Blocker—The Tri State Coal and Coke Co., recently incorporated with $100,000 capital stock, is in the market for mining and power plant equipment.

Okla., Gotebo—City plans to rebuild its electric lighting plant recently destroyed by fire.

Okla., Kiowa—The Kiowa Ice, Light and Water Co., recently incorporated with $50,000 capital stock, plans to install an electric plant and an ice factory. T. L. Sammons and M. T. Crane, interested.

Okla., Savannah—The Savannah Lighting and Milling Co., incorporated with $2000, plans to install a lighting plant.

Wash., Ephrata—The Ruff Lighting Co. has petitioned the Commissioners of Grant Co. for authority to build an electric transmission line along the highway in Grant County. S. R. Nelson and C. Reeder, incorporators.

Calif., Los Angeles—F. W. Slinkard, 1437 Wright St., is in the market for 25-30 motors, 440 3 phase vertical centrifugal pump with frame, No. 7.

N. S., Berwick—City plans to build an electric lighting and power plant. Estimated cost, $50,000. H. A. Cornwall, Clerk.

N. S., Halifax—The Nova Scotia Tramways and Power Co. plans to purchase new equipment including electric streets cars, electrical equipment and generating machinery. G. A. Fowler, Lower Water St., Engr.

Que., Makamik—Boisclair Bros. is in the market for sawmill and steam power equipment.

Que., Shawinigan Falls—The Laurentide Power Co. plans to install 3 additional units in its plant. J. E. Aldred, 24 Exchange Pl., New York City, Pres.

Ont., Dunwich Twp.—The Dominion Natural Gas Co., Ltd., Bank of Hamilton Bldg., plans to lay mains and establish a distributing system throughout the township.

Ont., Wallaceburg—The Dominion Glass Co. plans to install a gas producer plant. Estimated cost, $200,000.

Alta., Calgary—City is in the market for a motor generator set.

B. C., North Vancouver—City is considering plans for the erection of a hydro electric plant on the property of the Nairn Falls Power Co.

B. C., Revelstoke—The Lanark Mines Co. plans to build a power plant and dam in connection with its mine and mill here. Estimated cost between $25,000 and $30,000.

CONTRACTS AWARDED

N. H., Plymouth—The Plymouth Electric Light Co. is building a 2-mile electric transmission line from here to Livermore Falls. J. A. Walls, Lexington St. Bldg., Baltimore, Md., Engr.

Mass., Cambridge—The Technology has awarded the contract for the erection of a 1-story, 43 x 190 ft. engine building, to Stone and Webster Engineering Corporation, 147 Milk St., Boston. Estimated cost, $12,000.

N. Y., Binghamton—The Binghamton Light, Heat and Power Co. is building an addition to its electric power plant.

Penn., Philadelphia—The E. F. Benson Co., 926 North Delaware Ave., has awarded the contract for the erection of an engine plant, to W. Steele & Sons Co., 31 South 15th St.

Penn., Pittsburgh—The Heppenstall Forge and Knife Co., 47th and Hatfield St., has awarded the contract for the erection of a new boiler plant to C. Huntsman, Pittsburgh. Estimated cost, $23,000.

Wash., D. C.—The Bureau of Yards and Docks, Navy Dept., Wash., has awarded the contract for the erection of a frequency changer house and a substation, to the Dawson Constr. Co., May Bldg., Pittsburgh, Penn. Estimated cost, $52,520.

Calif., San Pedro—The Seacoast Canning Co., Los Angeles, has awarded the contract for the erection of a cannery and a brick boiler house here, to F. W. Colegrove, 573 7th St. Estimated cost, $23,000.

THE COAL MARKET

Boston—Current quotations per gross ton delivered alongside Boston points as compared with a year ago are as follows:

ANTHRACITE

	Circular May 2, 1918	Individual May 2, 1918
Buckwheat	$4.60	$7.10—7.35
Rice	4.10	6.65—6.90
Boiler	3.90	.....
Barley	3.60	6.15—6.40

BITUMINOUS

Bituminous not on market.

Pocohontas and New River, f.o.b. Hampton Roads, is $4, as compared with $2.85—2.00 a year ago.

*All-rail to Boston is $2.60. †Water coal.

New York—Current quotations per gross ton f.o.b. Tidewater at the lower ports* are as follows:

ANTHRACITE

	Circular May 2, 1918	Individual May 2, 1918
Pea	$4.90	$5.65
Buckwheat	4.45@5.15	4.80@5.50
Barley	3.40@3.65	3.80@4.50
Rice	3.90@4.10	3.00@4.00
Boiler	3.65@3.90	.....

Quotations at the upper ports are about 5c. higher.

BITUMINOUS

	F.o.b. N. Y. Gross	Mine Price Net	Gross
Central Pennsylvania	$5.06	$3.05	$3.41
Maryland—			
Mine-run	4.84	2.85	3.19
Prepared	5.06	5.05	3.41
Screenings	4.50	2.55	2.85

*The lower ports are: Elizabethport, Port Johnson, Port Reading, Perth Amboy and South Amboy. The upper ports are: Port Liberty, Hoboken, Weehawken, Edgewater or Cliffside and Guttenberg. St. George is in between and sometimes a special boat rate is made. Some bituminous is shipped from Port Liberty. The ratte to the upper ports is 5c. higher than to the lower ports.

Philadelphia—Prices per gross ton f.o.b. cars at mines for line shipment and f.o.b. Port Richmond for tide shipment are as follows:

	Line— May 2, 1918	Line— One Yr. Ago	Tide— May 2, 1918	Tide— One Year Ago
Pea	$3.45	$2.80	$4.35	$3.70
Barley	2.15	1.50	2.40	1.75
Buckwheat	3.15	2.50	3.75	3.40
Rice	2.65	2.00	3.65	3.00
Boiler	2.45	1.80	3.55	2.90

Chicago—Steam coal prices f.o.b. mines:

Illinois Coals	Southern Illinois	Northern Illinois
Prepared sizes	$2.65—2.80	$3.35—3.50
Mine-run	2.40—2.55	3.10—3.25
Screenings	2.15—2.30	2.85—3.00

Smokeless Coals	So. Ill., Pocohontas, Pennsylvania and W. Va.	Hocking, East Kentucky and West Va. Splint
Prepared sizes	$2.60—2.85	$2.85—3.35
Mine-run	2.40—2.60	2.60—3.00
Screenings	2.10—2.55	2.35—2.75

St. Louis—Prices per net ton f.o.b. mines are as follows:

	Williamson and Franklin Counties May 2, 1918	Mt. Olive & Staunton May 2, 1918	Standard May 2, 1918
6-in. lump	$2.65-3.00	$2.65-2.80	$2.65-2.80
2-in. lump	2.65-3.00	2.65-2.80	2.25-2.50
Steam egg	2.65-2.80	2.35-2.50	2.25-2.40
Mine-run	2.45-2.60	2.45-2.60	2.45-2.60
No. 1 nut	2.65-3.00	2.65-2.80	2.65-2.80
2-in. screen	2.15-2.40	2.15-2.40	2.15-2.40
No. 5 washed	2.15-2.30	2.15-2.30	2.15-2.30

Birmingham—Current prices per net ton f.o.b. mines are as follows:

	Mine-Run	Lump & Nut	Slack and Screenings
Big Seam	$1.90	$2.15	$1.65
Pratt, Jagger, Corona	2.15	2.40	1.90
Black Creek, Cahaba	2.40	2.65	2.15

Government figures.

Individual prices are the company circulars at which coal is sold to regular customers irrespective of market conditions. Circular prices are generally the same at the same periods of the year and are fixed according to a regular schedule.

Prices—Materials and Supplies

These are prices to the power plant by jobbers in the larger buying centers east of the Mississippi. Elsewhere the prices will be modified by increased freight charges and by local conditions.

ELECTRICAL SUPPLIES

KNIFE SWITCHES—Following are net prices each in cities named for knife switches mounted on slate base, front connected, punched clip type, 250 volts:

	30 Amp.	60 Amp.	100 Amp.	200 Amp.
D. P. S. T. fuseless	$0.52	$0.93	$1.90	$3.42
D. P. S. T. fused	.81	1.37	2.70	5.14
D. P. D. T. fuseless	.88	1.52	3.42	5.70
D. P. D. T. fused	1.67	2.58	5.62	9.88
T. P. S. T. fuseless	.78	1.40	2.86	5.14
T. P. S. T. fused	1.22	2.05	4.18	7.70
T. P. D. T. fuseless	1.37	2.35	5.24	8.82
T. P. D. T. fused	2.68	4.13	8.99	15.80

Lots $25 and more, list.

FUSES—Following are net prices of 250-volt inclosed fuses each, in standard packages, in cities named:

0-30 amperes ..... $0.11¼ each 110-200 amperes ..... $0.90 each
31-60 amperes ..... .15¾ each 225-400 amperes ..... 1.62 each
61-100 amperes .... .40 each

FUSE PLUGS (MICA CAP) PER 100

0-30 amperes.. 4c. each in standard package quantities (500)
0.30 amperes.. 5c. each for less than standard package quantities (500)

SOCKETS, B. B. FINISH—Following are net prices in cents each in standard packages:

⅛-IN. OR PENDANT CAP			⅜-IN. CAP		
Key	Keyless	Pull	Key	Keyless	Pull
22.10c.	21.00c.	42.00c.	27.30c.	26.20c.	46.20c.

Note—Less than standard package quantities, 15% off list.

CUT-OUTS—Following are net prices each in standard-package quantities:

CUT-OUTS PLUG

S. P. M. L.	$0.11	T. P. to D. P. S. B.	$0.24
D. P. M. L.	.18	T. P. to D. P. T. B.	.38
T. P. M. L.	.26	T. P. S. B.	.33
D. P. S. B.	.19	T. P. D. B.	.54
D. P. D. B.	.37		

CUT-OUTS, N. E. C. FUSE

	0-30 Amp.	31-60 Amp.	60-100 Amp.
D. P. M. L.	$0.33	$0.84	$1.68
T. P. M. L.	.48	1.20	2.40
D. P. S. B.	.42	1.05	....
T. P. S. B.	.81	1.80	....
D. P. D. B.	.78	2.10	....
T. P. D. B.	1.35	3.60	....
T. P. to D. P. D. B.	.90	2.52	....

ATTACHMENT PLUGS—Price each, in standard packages:

		Standard Package
Hubbell porcelain	$0.21	250
Hubbell composition	.12	50
Benjamin swivel	.12	100
Current taps	.35	50

FLEXIBLE CORD—Price per 1000 ft. in coils of 250 ft.:

No. 18 cotton twisted	$20.00
No. 16 cotton twisted	24.50
No. 18 cotton parallel	21.00
No. 16 cotton parallel	28.00
No. 18 cotton reinforced heavy	28.50
No. 16 cotton reinforced heavy	38.00
No. 18 cotton reinforced light	24.00
No. 16 cotton reinforced light	32.00
No 18 cotton Canvasite cord	25.00
No. 16 cotton Canvasite cord	32.00

RUBBER-COVERED COPPER WIRE—Per 1000 ft. in New York:

No.	Solid, Single Braid	Solid, Double Braid	Stranded, Double Braid	Duplex
14	$10.50	$12.50	$15.00	$23.50
12	14.23	16.92	19.48	32.25
10	16.92	22.83	25.81	45.00
8	27.65	31.40	35.50	61.00
6	....	....	56.00	....
4	....	....	76.40	....
2	....	....	112.45	....
1	....	....	152.26	....
0	....	....	182.90	....
00	....	....	223.60	....
000	....	....	271.24	....
0000	....	....	332.40	....

COPPER WIRE—Prices per 1000 ft. for rubber-covered wire in following cities:

	Denver			St. Louis			Birmingham		
No.	Single Braid	Double Braid	Duplex	Single Braid	Double Braid	Duplex	Single Braid	Double Braid	Duplex
14	$13.00	$15.00	$31.09	$13.50	$16.25	$31.25	$13.50	$17.40	$36.30
10	22.15	25.25	50.05	25.00	28.50	56.40	30.30	34.30	67.60
8	31.40	34.85	69.50	34.85	38.85	74.70	42.80	46.85	.....
6	49.40	53.30	.....	59.75	64.25	.....	63.60	74.10	.....
4	71.30	76.15	.....	84.40	84.90	.....	101.75	106.55	.....
2	108.00	113.65	.....	125.50	132.00	.....	151.50	163.00	.....
1	140.40	147.85	.....	163.00	171.15	.....	201.00	209.50	.....
0	176.85	176.85	.....	216.00	225.00	.....	276.00	285.00	.....
00	.....	239.45	.....	263.00	273.50	.....	317.00	330.00	.....
000	.....	293.15	.....	320.00	331.50	.....	417.00	428.00	.....
0000	.....	357.00	.....	388.50	400.50	.....	508.00	516.00	.....

LOOM—Price per 100 ft., in coils:

	Ft. in Coil			Ft. in Coil	
¼	250	$2.25	¾	150	$7.00
⅜	250	3.50	1	100	10.00
½	200	4.50	1¼	100	12.00
⅝	200	5.75	1½	100	15.00

CONDUITS, ELBOWS AND COUPLINGS—Following are warehouse net prices per 1000 ft. for conduit and per unit for elbows and couplings:

	Conduit		Elbows		Couplings	
In.	Enameled	Galvanized	Enameled	Galvanized	Enameled	Galvanized
½	$66.56	$71.66	$0.1602	$0.1716	$0.059	$0.0632
¾	87.75	94.65	.2108	.2258	.0843	.0903
1	129.71	139.91	.3119	.3341	.1096	.1174
1¼	175.49	189.29	.4019	.4289	.1518	.162
1½	209.83	226.33	.5358	.5718	.1875	.2001
2	282.31	304.51	.9823	1.05	.25	.2668
2½	446.36	481.46	1.61	1.71	.3572	.3812
3	583.70	629.60	4.28	4.57	.5358	.5718
3½	729.56	784.76	9.47	10.10	.7144	.7624
4	886.17	951.57	10.93	11.67	.893	.953

From New York Warehouse—Less 5% cash.

Standard lengths rigid, 10 ft. Standard lengths flexible, ½ in., 100 ft. Standard lengths flexible, ¾ to 2 in., 50 ft.

LOCKNUTS AND BUSHINGS—Following are net prices in standard packages, which are: ½-in., 1000; ¾- to 1¼ in., 100; 1½- to 2-in., 50:

	Locknuts Per 100	Bushings Per 100	Flexible Conduit Box Connections Per 100
½	$1.02	$1.68	$5.62
¾	1.75	4.00	7.12
1	3.00	6.15	10.50
1¼	5.00	8.20	15.00
1½	7.50	10.25	22.50
2	10.00	16.40	30.00
2½	12.30	24.60	67.50

ARMORED CABLES AND BOX CONNECTORS—Following are net prices per 1000 ft. cable and standard package of 100 box connectors in single and double strip:

Wire Gage	Twin Conductor Cable	Twin Conductor Connectors	Three Conductor Cable	Three Conductor Connectors
14	$65.00	$4.50	$103.50	$4.50
12	101.25	4.50	127.50	4.50
10	138.75	4.75	176.25	4.75
8	176.20	5.75	247.50	6.00
6	277.50	6.25	362.40	7.50
4	431.25	7.50	....	....

LAMPS—Below are present quotations in less than standard package quantities:

Straight-Side Bulbs				Pear-Shape Bulbs			
Mazda B— Watts	Plain	Frosted	No. in Package	Mazda C— Watts	Clear	Frosted	No. in Package
10	$0.30	$0.33	100	75	$0.70	$0.75	50
15	.30	.33	100	100	1.10	1.15	24
25	.30	.33	100	150	1.65	1.70	24
40	.30	.33	100	200	2.20	2.27	24
50	.30	.33	100	300	3.25	3.35	24
60	.35	.39	100	400	4.30	4.45	12
100	.70	.77	24	500	4.70	4.85	12
				750	6.50	6.75	8
				1000	7.50	7.75	8

Standard quantities are subject to discount of 10% from list. Annual contracts ranging from $150 to $300,000 net allow a discount of 17 to 40% from list.

WIRING SUPPLIES—New York prices for tape and solder are as follows:

Friction tape, ½-lb. rolls	35c. per lb.
Rubber tape, ½-lb. rolls	45c. per lb.
Wire solder, 50-lb. pools	45c. per lb.
Soldering paste, 1-lb. cans	50c. per lb.

FANS—It is prophesied that there will be a scarcity of electric fans this summer.

MISCELLANEOUS

HOSE—

	Fire 50-Ft. Lengths
Underwriters' 2½-in.	75c. per ft.
Common, 2½-in.	33⅓%

	Air		
	First Grade	Second Grade	Third Grade
¾-in. per ft.	$0.60	$0.35	$0.30

Steam—Discounts from list

First grade.... 25% Second grade.... 30% Third grade.... 40%

RUBBER BELTING—The following discounts from list apply to transmission rubber and duck belting:

Competition ..... 40% Best grade 15%
Standard 30%

LEATHER BELTING—Present discounts from list in the following cities are as follows:

	Medium Grade	Heavy Grade
New York	40%	35%
St. Louis	45%	40%
Chicago	30+10%	40+5%
Birmingham	35%	40%
Denver	35%	30%

RAWHIDE LACING—40%.

PACKING—Prices per pound:

Rubber and duck for low-pressure steam	$0.90
Asbestos for high-pressure steam	1.60
Duck and rubber for piston packing	1.00
Flax, regular	.90
Flax, waterproofed	1.10
Compressed asbestos sheet	1.00
Wire insertion asbestos sheet	1.20
Rubber sheet	.60
Rubber sheet, wire insertion	.90
Rubber sheet, duck insertion	.50
Rubber sheet, cloth insertion	.25
Asbestos packing, twisted or braided and graphited, for valve stems and stuffing boxes	1.10
Asbestos wick, ½- and 1-lb. balls	.70

PIPE AND BOILER COVERING—Below are discounts and part of standard lists:

PIPE COVERING		BLOCKS AND SHEETS	
Pipe Size	Standard List Per Lin.Ft.	Thickness	Price per Sq.Ft.
1-in.	$0.27	½-in.	$0.27
2-in.	.36	1 -in.	.30
6-in.	.80	1½-in.	.45
4-in.	.60	2 -in.	.60
3-in.	.45	2½-in.	.75
8-in.	1.10	3 -in.	.90
10-in.	1.30	3½-in.	1.05

85% magnesia high pressure ..... 5% off

For low-pressure heating and return lines { 4-ply ..... 58% off; 3-ply ..... 60% off; 2-ply ..... 62% off

GREASES—Prices are as follows in the following cities in cents per pound for barrel lots:

	Cincinnati	Chicago	St. Louis	Birmingham	Denver
Cup	7	5¼	6.9	7½	10½
Fiber or sponge	8	6	7.4	7½	15
Transmission	7	6	7.4	7½	13
Axle	4½	4	3.6	3	5
Gear	4½	4½	7.0	7½	6
Car journal	22 (gal.)	3½	4.5	3	6

COTTON WASTE—The following prices are in cents per pound:

	Chicago	New York Current	New York One Year Ago	Cleveland
Colored mixed	12.00 to 12.50	8.50 to 12.00	10.00 to 12.00	12.50
White	10.00 to 11.00	11.00 to 13.00	13.00 to 15.00	16.00

WIPING CLOTHS—In Cleveland the jobbers' price per 1000 is as follows:

13¼ x 13½ ..... $45.00 13¼ x 20½ $52.00

In Chicago they sell at $30@33 per 1000.

LINSEED OIL—These prices are per gallon:

	New York Current	New York One Year Ago	Cleveland Current	Cleveland One Year Ago	Chicago Current	Chicago One Year Ago
Raw per barrel	$1.55*	$1.13	$1.65	$1.13	$1.65	$1.05
5-gal. cans	1.65*	2.23	1.80	1.23	1.75	1.15

* Nominal.

WHITE AND RED LEAD in 500-lb. lots sell as follows in cents per pound:

	Red Current Dry	Red Current In Oil	Red 1 Year Ago Dry	Red 1 Year Ago In Oil	White Current Dry and In Oil	White 1 Yr. Ago Dry and In Oil
25- and 50-lb. kegs	11.50	11.00	10.50	11.00	10.50	10.50
12½-lb. keg	11.75	11.25	10.75	11.25	10.75	10.75
100-lb. keg	11.25	11.50	11.00	11.50	11.00	11.00
1- to 5-lb. cans	13.25	13.00	12.50	12.50	13.00	12.50

Note—Price change imminent.

RIVETS—The following quotations are allowed for fair-sized orders from warehouse:

	New York	Cleveland	Chicago
Steel ⅞ and smaller	30%	35%	40%*
Tinned	30%	35%	40%*

*For less than keg lots the discount is 35%.

Button heads, ¾, ⅞, 1 in. diameter by 2 in. to 5 in. sell as follows per 100 lb.:

New York ..... $6.09½ Cleveland ..... $5.85 Chicago $5.50

Coneheads, same sizes:

New York ..... $6.19½ Cleveland ..... $5.95 Chicago $5.60

FIRE BRICK—Quotations on the different kinds in the cities named are as follows, f.o.b. works:

	New York	Chicago
Silica brick, per 1000	$50.00 to 55.00	$50.00
Fire clay brick, per 1000, No. 1	45.00 to 55.00	.....
Magnesite brick, per net ton	135.00 to 145.00	.....
Chrome brick, per net ton	.....	.....
Deadburned magnesite brick, per net ton	85.00 to 90.00	.....
Special furnace chrome brick, per net ton	.....	60.00 to 80.00

Standard size fire brick, 9 x 4½ x 2½ in. The second quality is $4 to $5 cheaper per 1000.

St. Louis—High grade, $55 to $65; St. Louis grade, $40 to $55.
Birmingham—Fire clay, $35.
Chicago—Second quality, $25 per ton.
Denver—Silica, $35 per 1000.

FUEL OIL—Price variable, depending upon stock. New York quotations not available owing to this fact. In Chicago and St. Louis the following prices are quoted:

	Chicago	St. Louis
Domestic light, 22-26 Baumé	5c.	None
Mexican heavy, 12-14 Baumé	7c.	7 7/10c.

Note—There is practically no fuel oil in Chicago at present time.

SWEDISH (NORWAY) IRON—The average price per 100 lb., in ton lots, is:

	Current	One Year Ago
New York	$15.00	$9.50
Cleveland	15.00	7.00
Chicago	15.00	8.25

In coils an advance of 50c. usually is charged.
Note—Stock very scarce generally.

POLES—Prices on Western red cedar poles:

	New York	Chicago	St. Louis	Denver
6 in. by 30 ft.	$5.59	$4.94	$4.94	$4.32
7 in. by 30 ft.	7.40	6.60	6.60	5.80
7 in. by 35 ft.	10.70	9.60	9.60	8.55
8 in. by 35 ft.	12.20	10.90	10.90	9.65
7 in. by 40 ft.	12.35	11.00	11.00	9.75
8 in. by 40 ft.	13.75	12.15	12.15	10.65
8 in. by 45 ft.	18.20	16.20	16.20	14.30
8 in. by 50 ft.	21.85	19.45	19.45	17.15

10c. higher freight rates on account of double loads.

For plain pine poles, delivered New York, the price is as follows:

10-in. butts, 5-in. tops, length 20-30 ft.	$ 9.00
12-in. butts, 6-in. tops, length 30-40 ft.	11.50
12-in. butts, 6-in. tops, length 41-50 ft.	12.50
14-in. butts, 6-in. tops, length 51-60 ft.	21.00
14-in. butts, 6-in. tops, length 61-71 ft.	23.50

PIPE—The following discounts are for carload lots f.o.b. Pittsburgh, basing card in effect July 2, 1917, for iron, and May 1 for steel:

BUTT WELD

Steel Inches	Steel Black	Steel Galvanized	Iron Inches	Iron Black	Iron Galvanized
¾ to 3	49%	35½%	¾ to 1½	33%	17%

LAP WELD

2	42%	29½%	2	26%	12%
2½ to 6	45%	32½%	2½ to 4	28%	15%
7 to 12	42%	28½%	4½ to 6	28%	15%
13 and 14	32½%	....	7 to 8	20%	8%
15	30%	....			

BUTT WELD. EXTRA STRONG PLAIN ENDS

¾ to 1½	47%	34½%	¾ to 1½	33%	18%
2 to 3	48%	35½%			

LAP WELD. EXTRA STRONG PLAIN ENDS

2	40%	28½%	2	27%	14%
2¼ to 4	43%	31½%	9 to 12	15%	3%
4½ to 6	42%	30½%	7 to 12	25%	12%
7 to 8	38%	24½%	2½ to 4	29%	17%
9 to 12	33%	19½%	4½ to 6	28%	16%

From warehouses at the places named the following discounts hold for steel pipe:

	Black New York	Black Chicago	Black St. Louis
¾ to 3 in. butt welded	38%	42%	34.27%
3½ to 6 in. lap welded	18%	38%	21.27%
7 to 12 in. lap welded	10%	35%	21.27%

	Galvanized New York	Galvanized Chicago	Galvanized St. Louis
¾ to 3 in. butt welded	22%	22%	19.27%
3½ to 6 in. lap welded	List	18%	13.27%
7 to 12 in. lap welded	List+20%	20%	6.27%

Malleable fittings, Class B and C, from New York stock sell at 5 and 5% from list prices. Cast iron, standard sizes, 34 and 5%.

BOILER TUBES—The following are the prices for carload lots f.o.b. Pittsburgh, announced Nov. 13, as agreed upon by manufacturers and the Government:

Lap Welded Steel		Charcoal Iron	
3½ to 4½ in.	34	3½ to 4½ in.	12½
2½ to 3¼ in.	24	3 to 3¼ in.	+ 5
2¼ in.	17½	2½ to 2¾ in.	+ 7½
1¾ to 2 in.	13	2 to 2¼ in.	+22½
		1¾ to 1⅞ in.	+35

Standard Commercial Seamless—Cold drawn or hot rolled:

Per Net Ton		Per Net Ton	
1 in.	$340	1¾ in.	$220
1¼ in.	280	2 to 2½ in.	190
1⅜ in.	270	2¾ to 3¾ in.	180
1½ in.	220	4 in.	200
		4½ to 5 in.	220

These prices do not apply to special specifications for locomotive tubes nor to special specifications for tubes for the Navy Department, which will be subject to special negotiation.